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PLATE LXV. SUBMARINE EXCAVATIONS. See page 2437.

THE

# PRACTICAL

# DICTIONARY OF MECHANICS:

BEING

A DESCRIPTION OF TOOLS, INSTRUMENTS, MACHINES, PROCESSES, AND ENGINEERING; HISTORY OF INVENTIONS; GENERAL TECHNOLOGICAL VOCABULARY;

AND

*DIGEST OF MECHANICAL APPLIANCES IN SCIENCE AND THE ARTS.*


By EDWARD H. KNIGHT,

CIVIL AND MECHANICAL ENGINEER, ETC., U.S.


Illustrated

WITH UPWARDS OF FIVE THOUSAND ENGRAVINGS.

DIVISION VI.

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"Thus Time brings all things, one by one, to sight,
And Skill evolves them into perfect light."

LUCRETIUS, Book V.

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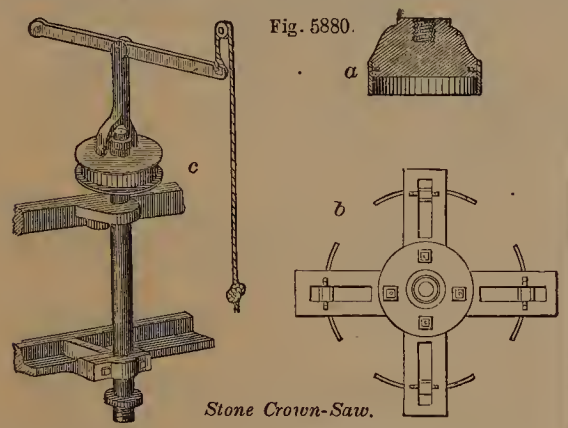
uprights *a a* have grooves in which the frames *b b* slide; these carry rollers at their lower ends, upon which the frame *c* containing the saws rests. The saws are held between clamps, having hooks, by which they are attached to the frame *b*; they are strained by wedges, and kept equidistantly apart by iron blocks of the exact thickness of the slabs to be sawn. The saw-frame is traversed by a jointed connecting-rod, attached by an adjustable loop to a long vibrating pendulum kept in motion by a pair of connecting-rods, one above the other, leading from two cranks driven by the engine.

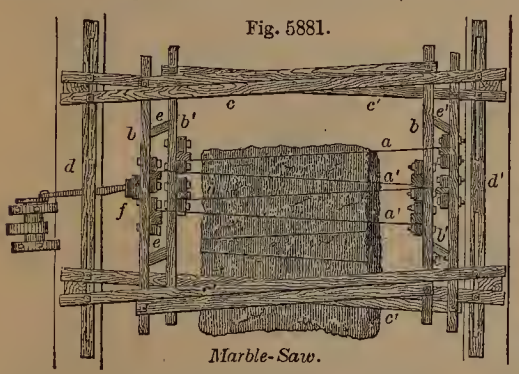
The frames *b b* are suspended by chains, and are counterpoised, they and the saw-frames having sufficient preponderance to descend as the cutting proceeds. The trough *d* contains water, which flows through a number of apertures into the sand-box *e*, where it is conducted through curved channels conveying the sand to openings, whence it may drop into the kerfs made by the saws.

Fig. 5880.




*Stone Crown-Saw.*

Fig. 5881.

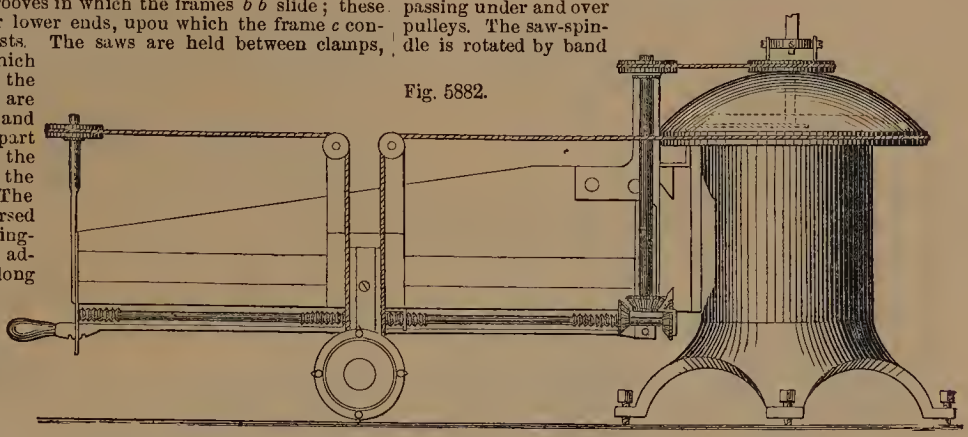



*Marble-Saw.*

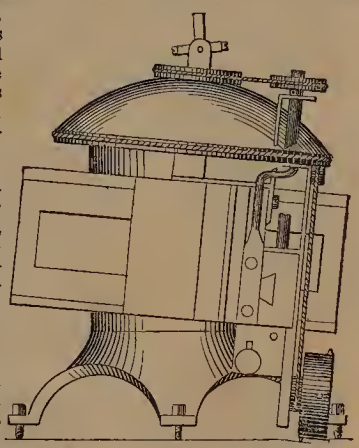
In Figs. 5877, 5878, the saws are arranged in gangs, being adjustable as to distance according to the thickness of slabs required. Each saw is strained between stirrups at the respective ends, attached to the frame, which is suspended by rods in such a manner as to admit of a free horizontal reciprocation. The saw-frame is attached to a cast-iron box, which is movable upon a vertical post, from whence it receives its reciprocating motion. Two sets of saws are shown in the illustration, moved by means of a crank through the intervention of a swinging frame. To the same frame are attached two polishing-blocks, which reciprocate upon the tables, to which is imparted a motion in a direction at right angles to the former. This prevents the *worker* from wearing the marble into grooves. The saws are guided between vertical posts, and receive sand and water from a reservoir and apron above.

Fig. 5879 shows a gang of circular stone-saws mounted on a bench having rails, upon which a carriage is traversed by a weight and cord passing under and over pulleys. The saw-spindle is rotated by band and pulley in such a direction that the saws may have an upward cut, acting against the end of the stone as it is pressed against them by the forward movement of the carriage.

Fig. 5882.

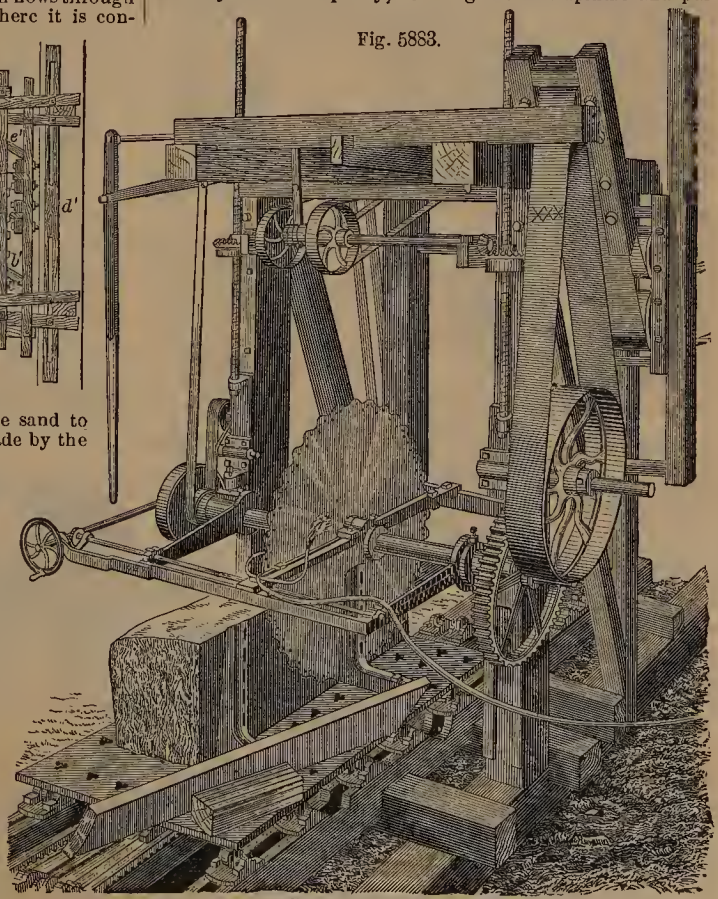


For circular work, such as the tops of circular tables, disks for bosses or ornaments, lamp-bases, etc., a cylindrical saw is employed, similar in principle to the crown-saw. For small work, hollow cylinders of sheet-iron *a* are employed. For large circles, segmental cutters, adjustably fixed upon the arms of a cross piece, are used. In either case, the vertical spindle *c* is rotated by a belt and pulley, the weight of the spindle and pul-



*Gilmore's Millstone Saw-Drill.*

Fig. 5883.



*Stone-Sawing Machine.*



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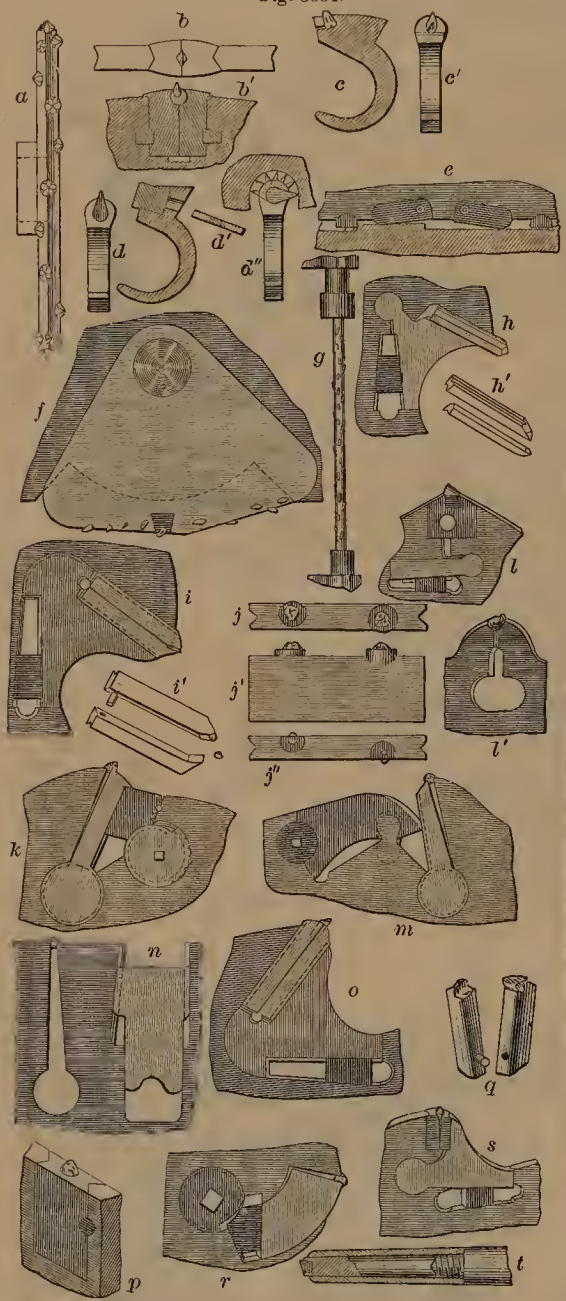
Fig. 5884.




*Modes of Fastening Diamonds in or to Stone-Saws.*

ley being relied on to keep the saw to its work, and a cord and lever are employed to lift it when required.

The machine, Fig. 5881, is designed for sawing taper slabs by means of two sets of saws operated from a single crank.

The saws *a a a a* are secured to the fender-bars *b b b' b'*, and those of the one set are adjusted at any angle with those of the other by the lateral movement of the fender-bars corresponding to the relative inclinations of the guides *c c c' c'*, which may be secured in the required position by bolts near their ends passing through slots in the rails *d d'*. The two sets of fender-bars are connected by links *e e e' e'*, so that the adjustment of one determines that of the other, and at the same time motion is imparted to both by the connection of the crank with a post *f* attached to the first set of fender-bars.

Stone-sawing machines of the highest class are made by furnishing the blade with CARBON-POINTS (which see). These saws are usually circular, but some are made reciprocating.

James T. Gilmore of Painesville, Ohio, No 38,670, May 20, 1863, has a circular revolving plate or disk, armed with diamonds or other hard cutting-points, and used for dressing millstones. A portion of the machine is shown in Fig 5882. It is described as adapted to leveling the surface of, and cutting the furrows in buhr-stones, dressing building-stones, fluting columns, and making moldings. The view shows side and end elevations.

Diamond-drills are described in Hermann's French patent, March 31, 1855. See DIAMOND-DRILL.

Fig. 5883 shows a stone-sawing machine having a circular blade in a frame, which may be raised or lowered, to bring the saw to cut at the required depth. The stone is dogged upon a reciprocating bed beneath, in the manner of a planing-machine. The various adjustments will be easily understood from the figure.

Fig 5884 shows a number of ways of fastening the black diamonds to the steel blade.

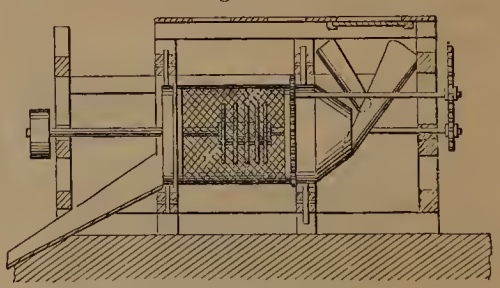
*a* shows Drake's patent, April 11, 1865.
*b b'* are Young's patent, June 8, 1869.
*c c'*, Young's patent, October 12, 1869.
*d d' d'*, Young's patent, February 1, 1870.
*e*, Young's patent, September 27, 1870. This has a reciprocating motion.
*f*, Young's patent, October 18, 1870. This also reciprocates.
*g*, Gear's patent, April 16, 1872. This is a gig-saw, having vertical reciprocation.
*h h'*, Emerson's saw, April 25, 1871.
*i i'*, Emerson's, June 4, 1872.
*j j' j''*, Smith's, May 27, 1873.
*k*, Husbands's, January 20, 1874.
*l l'*, Emerson's, for circular and straight saws respectively.
*m*, Husbands's, January 20, 1874.
*n*, Branch's, March 3, 1874.
*o*, Emerson's, May 26, 1874.
*p*, Husbands's, June 2, 1874.
*q*, Emerson's.
*r*, Husbands's, June 23, 1874.
*s*, Emerson's.
*t*, Dickinson's, August 11, 1874.

It will be perceived that some of these imbed the diamond in the saw by sockets, rings, or solder; others grasp it by fingers which are clamped in sockets; others grasp it by wedges in the slot, or by clamps which are themselves jammed by wedges, etc.

**Stone-sep'a-ra'tor.** A machine for separating stones from clay or sand; for concrete or brick-making.

Fig. 5885 shows a dry-clay pulverizer and stone-separator, in which the ground clay from the mill at the right is carried into

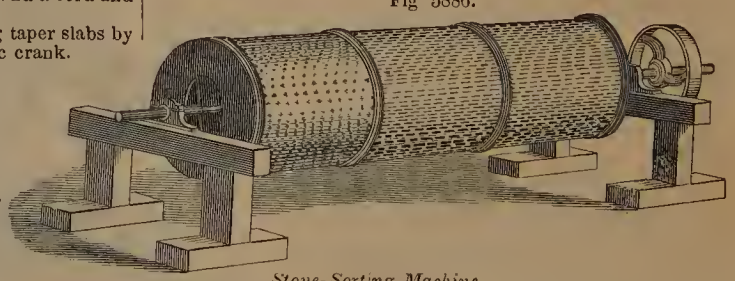
Fig 5885.



*Clay-Pulverizer and Stone-Separator.*

a revolving screen, in which is a shaft with stirrers rotating at a different speed. While material of a given fineness passes through the holes in the screen, the stones are discharged at an end spout.

Fig 5886.



*Stone-Sorting Machine.*

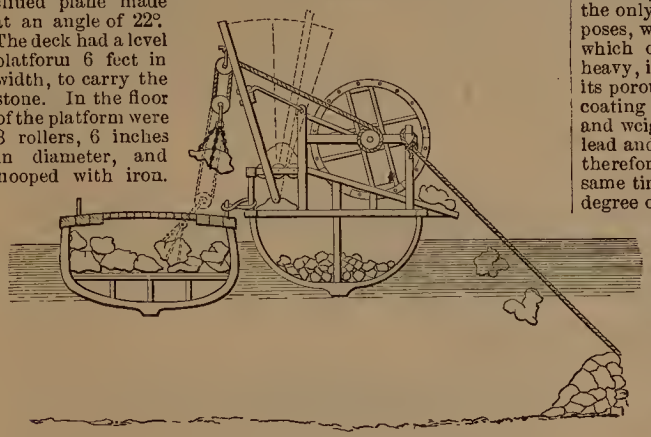
**Stone-sort'ing Ma-chine'.** A machine having an inclined iron cylinder perforated to allow stones of given sizes to escape. The machine has three sections of varying fineness of mesh, the crushed stone being fed in at the fine end, in the manner of a flour-bolt, and sorts into three sizes the pieces not too

large to fall through. These larger pieces pass all the way through, and are discharged at the end of the cylinder.

**Stone-ves'sel.** The breakwater of Cherbourg, France, was commenced in 1786, and was never completed according to the original design by De Cessart, but during the nine following years, 100,000,000 cubic feet of stone had been deposited in and around the 18 timber cones which formed the nuclei for the stone piles.

Fig 5887.

De Cessart's machine for throwing large stones into the sea consisted of a pontoon carrying an inclined plane made at an angle of 22°. The deck had a level platform 6 feet in width, to carry the stone. In the floor of the platform were 3 rollers, 6 inches in diameter, and hooped with iron.



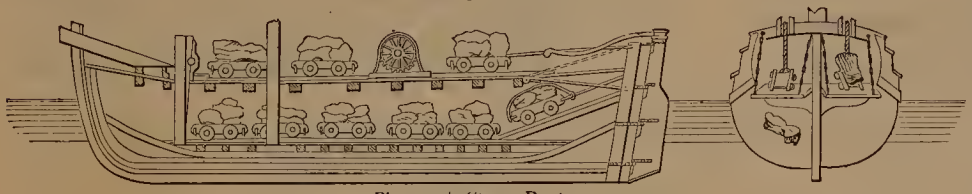
*De Cessart's Stone-Boat.*

A gib, moving on a pivot and furnished with hoisting-tackle, was employed to hoist the stones from the lighter which carried them to the spot. Two wheels and axles worked the rope. The wheels were 12 feet in diameter, the axles 1.

Iron grapplers and chains first lifted the stone from the lighter, and when the necessary hight was obtained, the gib was swung back into the position shown in dotted lines. By loosening the tackle a little, the stone was deposited on the platform rollers, along which it traveled until it reached the discharging-chute, which precipitated it into the sea.

In transporting and depositing the stones used in making the Plymouth Breakwater, vessels were employed having a pair

Fig 5888.



*Plymouth Stone-Boat.*

of longitudinal tracks on each side of the ship, on each deck. On these tracks were trucks which held the stone, which were dumped at the stern, to which the trucks were conducted, one at a time, and tilted by tackle. At the stern of the boat was an inclined plane, by which the loaded trucks reached the lower deck, and another inclined plane led from the upper deck to the opening in the stern, which was exposed when the shutters were lowered. These shutters were supported by chains, and formed chutes.

**Stone'ware.** A grade of ceramic ware of great hardness and value.

The stoneware of London is made of pipe-clay from Dorsetshire and Devonshire, calcined and ground flint from Staffordshire, and sand from Woolwich and Charlton. The dry clay is pulverized and sifted. The ingredients are compounded in different proportions, according to the fineness of the ware, its size, and purpose. The round articles are turned on a wheel, dried, and shaved in a lathe. Articles of other shapes are molded. The articles are then stacked in the kiln, with pieces of well-sanded clay placed between them, to prevent their adhering. A slow fire dissipates the moisture, and the heat is then raised until the flame and ware have the same color.

The glaze is then added by pouring 20 or 30 ladlefuls of common salt into the top of the kiln. This is volatilized by heat, becomes attached to the surface of the ware, and is decomposed, the muriatic acid flying off and leaving the soda behind it to form a fine thin glaze on the ware, which resists ordinary acids.

The labors of Wedgwood date from about 1762, and the art attained great excellence under his fostering care, ingenuity, and taste. We quote from Aiken: —

"With a liberal ambition far above the mere love of gain, his ruling object was to carry the art that he practiced to the utmost perfection of which it was capable. For this he spared neither time, nor labor, nor expense; and his splendid success, inciting others to follow in the same track, has secured to his country a most important branch of internal and foreign commerce, and has placed his name forever among the worthies of the British nation.

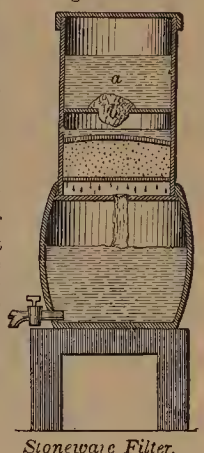
"He perceived that the defects of the delft-ware, at that time the only species of pottery employed for common domestic purposes, were the softness and looseness of texture of its body, which obliged the potter to make it thick and clumsy and heavy, in order to ensure to it a moderate durability; and that its porousness, as well as its dirty gray color, required a thick coating of white enamel, which added still farther to its bulk and weight, and which, containing a large proportion both of lead and arsenic, was hardly safe for culinary use. He began, therefore, by inventing a body for earthenware, which at the same time should be white and capable of enduring a very high degree of heat without fusion, well knowing that the hardness of the ware depended upon the high firing to which it had been subjected. For this purpose, rejecting the common clays of his neighborhood, he sent as far as Dorsetshire and Devonshire for the whiter and purer pipe-clays of those counties. For the silicious ingredient of his composition, he made choice of chalk-flints calcined and ground to powder.

"It might be supposed that white sand would have answered his purpose equally well and have been cheaper; but being determined to give the body of his ware as great a degree of compactness as possible, it was necessary that the materials should be reduced to the state almost of an impalpable powder; and calcined flints are much more easily brought to this state by grinding than sand would be. The perfect and equable mixture of these two ingredients being a point of great importance, he did not choose to trust merely to the ordinary mode of treading them together when moist, but having ground them between stones separately with water to the consistence of cream, he mixed them together in this state by measure, and then evaporating the superfluous water by boiling in large cisterns, he obtained a composition of the most perfect uniformity in every part. By the combination of these and other ingredients in different proportions, and exposed to different degrees of heat, he obtained all the variety of texture required, from the bibulous ware employed for glazed articles, such as common plates and dishes, to the compact ware not requiring glazing, of which he made mortars and other similar articles.

"The almost infusible nature of the body allowed him also to employ a thinner and less fusible glaze, that is, one in which no more lead entered than in common flint-glass, and therefore incapable of being affected by any articles of food contained or prepared in such vessels. With these materials, either in their natural white or variously colored, — black by manganese, blue by cobalt, brown and buff by iron, — he produced imitations of the Etruscan vases and of various other works of ancient art, such as the world had never before seen, such as no subsequent artist had ever attempted to rival.

"In table ware, for many years he led the way almost without a rival; but the immense demands occasioned by the successive improvements of this article, which first put down the use of delft, and then of pewter, gave ample room to men of capital and skill to enter the field of profit and competition. Much good has hence resulted; many subordinate improvements have been effected and are almost daily making; but it is to be regretted that many of the most modern ones have reference rather to cheapening the price than improving the quality of the ware or even keeping it up to the original standard."

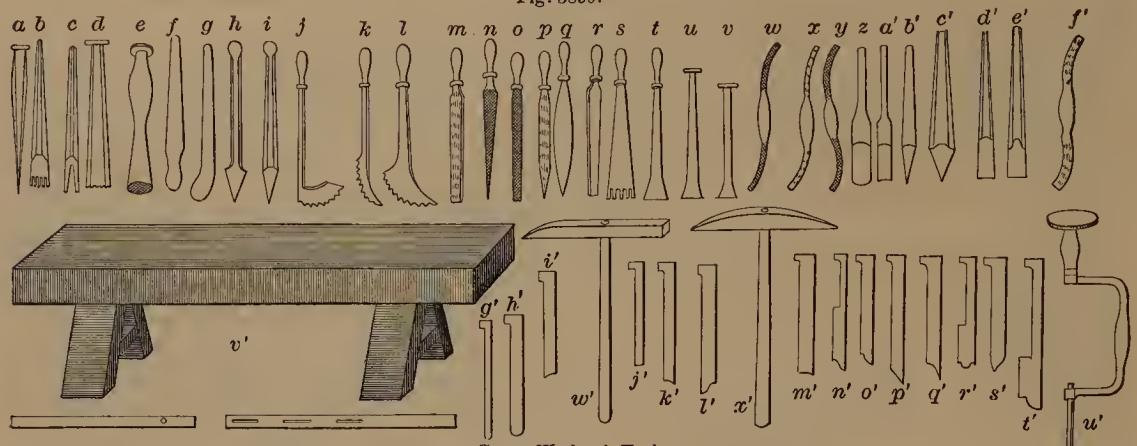
Fig. 5889.




*Stoneware Filter.*

**Stone'ware Fil'ter.** A sim-

Fig. 5890.




*Stone-Workers' Tools.*

ple filter consists mainly of two stoneware vessels, the one being placed on the other, and the lower on a stand or table. The water is placed in the vessel *a*, and thence percolates through the sponge *b*, which detains large impurities, thence through a perforated earthenware plate, 6 inches of charcoal, and a second plate, reaching the lower vessel, whence it is drawn as required, by means of the faucet.

### Stone-work'ing Tools.

Figs. 5890, 5891, show groups of stone-workers' tools.
*a*, square etching-needle.
*b*, marteline-chisel.
*c*, toothed chisel.
*d*, marteline-chisel.
*e*, puncheon.
*f*, *g*, scrapers for sinking flutings.
*h*, *i*, etching-needles, called *houguettes*, partly flattened, and sharp.
*j*, hook for leveling cavities.
*k*, rouud-nose chisel, for leveling cavities.
*l*, sharp-edged notched scraper, for sinking flutings.
*m*, half-round rasp.
*n*, round file.
*o*, flat file.
*p*, German half-round rasp.
*q*, *r*, safe-side rasps.
*s*, *t*, marteline-chisels.
*u*, *v*, puncheons.
*w*, *x*, *y*, parting-tools, with curved ends iu rasp or file.
*z*, *a'*, gravers and *burins*.
*b'*, *c'*, houguettes, or etching-needles.
*d'* *e'*, gravers and *burins*.
*f'*, parting-tool, with curved rasps.
*g'* to *t'*, molding-chisels and scrapers having edges, of varying patterns.
*u'*, *wimble*, for drilling.
*v'*, stone-workcr's bench.
*w'* *x'*, marteline-hammers.
*y'*, square.
*z'*, triangle.
*a''*, bevel.
*b''* *c''* *d''*, rules and straight-edges.
*e''* *f''* *g'*, saws of various sizes and construction.
*h''* *i''* *j''* *k''*, compasses of various sizes and forms.
*l''*, *sebil'a*, or wooden bowl for holding sand and water.
*m'*, hand saw.
*n''*, level.
*o''*, mallet.
*p''* *q''*, sledges.
*r''* *s''* *t'* *u'*, chisels of various sizes.
*v''*, ladle for feeding sand and water to the saw.
*w''* *x''*, hand-saws.

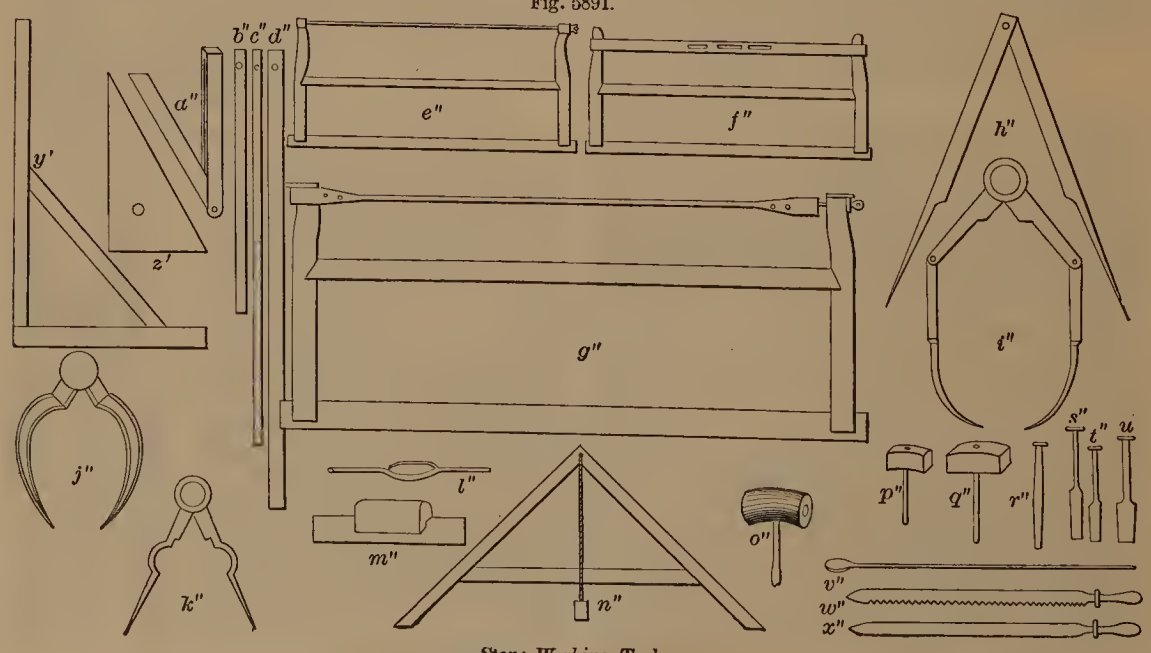
**Stook.** (*Husbandry.*) A collection of sheaves set up together so as to be mutually supporting. The more usual word in the United States is a *shock*. See SHOCK.

**Stool.** 1. (*Furniture.*) A kind of seat; usually a circular block supported on three or four legs.

Stools are known by construction, as *folding;* or by purpose, as *camp*, *night*, *foot*, *piano*, etc.

2. (*Agriculture.*) A frame of four growing corn-

Fig. 5891.




*Stone-Working Tools.*

stalks, tied together to form a support for a corn-shock.

3. (*Shipbuilding.*) *a.* (*pl.*) Chocks beneath the transoms for the attachment of the fashion-pieces.

*b.* A piece of plank fastened to a ship's side to receive the bolting of the gallery.

*c.* A small channel on a ship's side for containing the dead-eyes of the back-stays.

4. The sill of a window.

5. A decoy-bird.

**Stop.** 1. (*Music.*) *a.* A device for changing the tone of a wind-instrument by directing the wind to certain optional series of pipes or reeds of different tones; such as *principal*, *flute*, *diapason*, etc.

*b.* A set of pipes in an organ, of given quality and embracing all the tones and semitones within the range for which they are constructed. By means of a variety of stops the organist can change the quality of tone, the power of sound, and the compass of the instrument.

*Stops*, so called, were first introduced into harpsichords about the middle of the eighteenth century. They were worked by pedals, and known as the *forte*, *soft*, and *buff*. The first lifted the dampers; the second partly stopped the vibrations of the strings; the third interposed a piece of cloth or *buff* leather between the strings and the jacks. This was apparently the origin of pedals.

The *stops* of an organ are *mouth* and *reed*. The *mouth*-stops are divided into *foundation* or *octave* stops and *mutation*-stops. The *foundation*-stops are *open* or *closed*; the latter, called *bourdons*, are an octave above the open pipes of the same size.

The *mutation*-stops have this peculiarity that they give above each sound its third, its fifth, its tenth, in such a way as to represent by the action of several small pipes the aliquot parts or harmonics of the large pipe.

The names of the stops of each class, *mouth* and *reed*, and their sub-classes, are numerous. See Rimbault, "On the Organ."

As different stops vary in *pitch* and in *timbre*, a key will sound different notes and tones according as different *stops* are drawn.

The stops which sound the fundamental note are denominated *unison*, and agree in pitch, although they differ in *timbre*.

Stops sounding an octave above the unison are termed *octave*, and those sounding an octave below it are called *double*; as *diapason*, *double diapason*, etc.

Stops with open or closed pipes are so denominated, as *open diapason*, *closed diapason*.

*Principal* is a stop whose name indicates that it is the first stop tuned, the other stops being tuned from it.

*Diapason*-stops extend through the whole scale of the instrument, as the name implies.

Some stops are known by the interval which any note of the given stop makes with the fundamental note corresponding to the key struck, as *twelfth*, *fifteenth*, etc.

The following stops are those in common use: —

1. *Open diapason:* has metallic mouth-pipes, open at the upper end.

2. *Stopped diapason:* wooden mouth-pipes, in unison with 1, and having tompions in the upper end.

3. *Double diapason:* wooden mouth-pipes, open, pitched an octave lower than 1.

4. *Principal:* metallic mouth-pipes, pitched an octave higher than 1.

5. *Dulciana:* an open metallic mouth-pipe, tuned in unison with 1, and having relatively long and narrow pipes.

6. *Twelfth:* metallic mouth-pipe, tuned a twelfth above 1.

7. *Fifteenth:* metallic mouth-pipe, tuned an octave above *principal*.

8. *Flute:* wood *or* metal mouth-pipes, in unison with *principal*.

9. *Trumpet:* reed-pipes of metal in unison with 1.

10. *Clarion*, also called *octave-trumpet:* metallic reed-pipes, tuned an octave higher than *trumpet*.

11. *Bassoon:* reed-pipes in unison with 1, but extending only a part of the scale.

12. *Cremona* (krum-horn): reed-pipes in unison with 1.

13. *Oboe:* reed-pipes in unison with 1.

14. *Vox humana:* reed-pipes in unison with 1.

Many others might be mentioned of peculiar tone, as *clarinet*, *cornet*, *vox celeste*, etc.

*Compound stops* consist of several sets of stops aggregated to form harmonic combinations. Such are the *sesquialtera*, *cornet*, *mixed*.

It will be noticed that a number of the above are described as *reed-pipes in unison with* 1. The cause of the difference in *timbre*, or quality of tone, may be partially in the tongue, but is mainly produced by varying the form of the tube. The tubes have varying lengths and proportions, more or less elongated, with swells and other peculiarities which affect the character of the tone emitted.

Some large church-organs have numerous stops not here enumerated, such as the *tierce*, *larigot*, *nineteenth*, *twenty-second*, *twenty-sixth*, *twenty-ninth*, *thirty-third*, tuned at these intervals above *open diapason*.

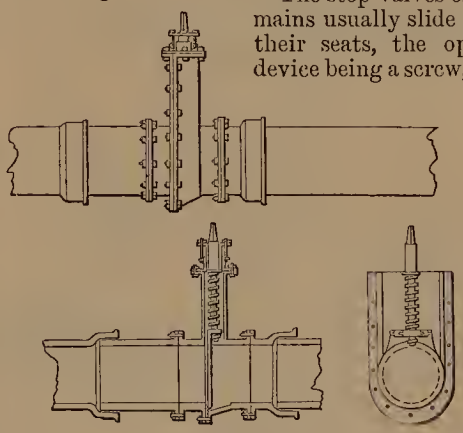
The organ of the church of S. Alessandro, in Colonna at Bergamo, built by Serassi in 1782, has 100 stops and 4 banks of keys. The Boston organ has 120 stops. See ORGAN

2. (*Nautical.*) A projection at the upper part of a mast, outside of the checks.

3. (*Optics.*) A perforated diaphragm between two lenses, to intercept the extreme rays that might disturb the perfection of the image.

**Stop-cock.** A faucet in a pipe, to open or close the passage.

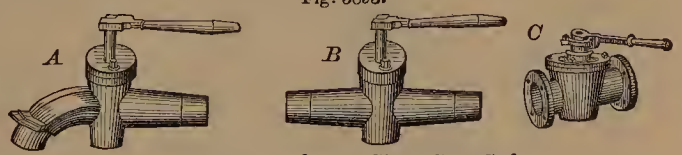
Fig. 5892.



*Stop-Valve.*

The stop-valves of water-mains usually slide against their seats, the operative device being a screw, turned by a handle. A turnkey inserted from above fits over the square of the screw, whose thread traverses in a nut formed by a projecting flange on the back of the valve. See STOP-VALVE.

Fig. 5893.




*A, Gland Bib-Cock. B, Gland Stop-Cock. C, Smith and Rowe's Patent Stop-Cock.*

**Stop-cyl'in-der Press.** (*Printing.*) One in which the impression-cylinder is stationary during the return of the bed. While the bed returns the next sheet is adjusted. See CYLINDER-PRESS; also LITHOGRAPHIC PRESS, Fig. 2977.

**Stope.** (*Mining.*) A horizontal bed. To stope; to excavate horizontally layer after layer.

**Stop-fin'ger.** A device in a silk-doubling machine for stopping the motion of the bobbin if the thread break. See FALLER-WIRE.

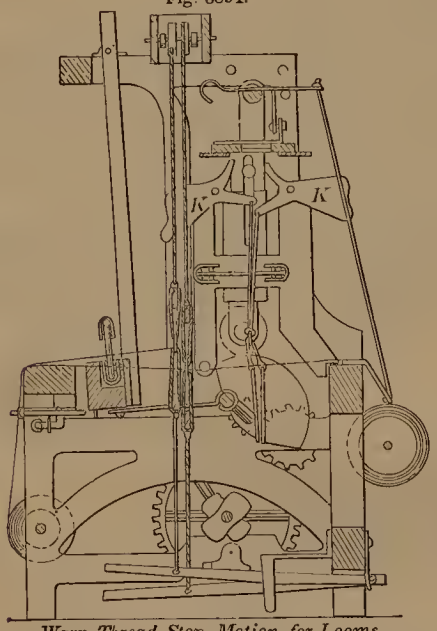
**Stop-mo'tion.** An arrangement in a machine by which the breakage of material in transitu, or the failure of supply of the material under treatment, causes an arrest of the motion.

Such, for instance, is the attachment in power-looms and knitting-machines, designed instantly to arrest the movement, if at any time the spool become exhausted in the shuttle, or the yarn happen to break. A delicate metallic finger feels for the yarn at the very instant the shuttle completes its course. If the yarn is in its place it rests there, and the work goes on; if not, it makes an electric contact, and the power is paralyzed in an instant. In pattern work the advantage of such an attachment will easily be understood. No time is lost in studying to find where the pattern began to be interrupted, and no trouble is necessary to set backward the Jacquard guides.

Fig. 5894 is a stop-motion for warps of looms.

It has a series of pivoted wings *K K* from which warp-supporting rods or threads are suspended. So long as the warp-supporting rods or threads are kept tense by the warp-thread, they hold the wings in such a position that the same do not in-

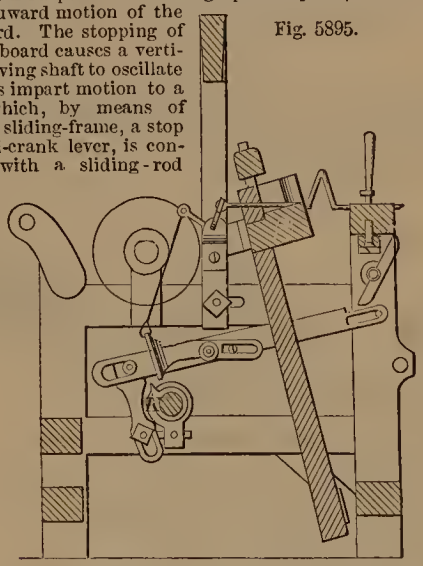
Fig. 5894.




*Warp-Thread Stop-Motion for Looms.*

terfere with the motion of a rising and falling flat board; but as soon as a warp-thread breaks, it will cause the release of a warp-supporting rod or cord, whereupon the wing from which the same is suspended will swing upon its pivot, so as to arrest the dowuward motion of the flat board. The stopping of the flat board causes a vertically moving shaft to oscillate and thus impart motion to a lever, which, by means of cords, a sliding-frame, a stop and bell-crank lever, is connected with a sliding-rod

Fig. 5895.



*Weft-Thread Stop-Motion for Looms.*

which operates the belt-shifting lever. As soon as the rod is released by the withdrawal of the stop, it is moved by the action of a spring, so as to shift the belt to a loose pulley and thus stop the loom, the batten being simultaneously arrested by a stop on said rod.

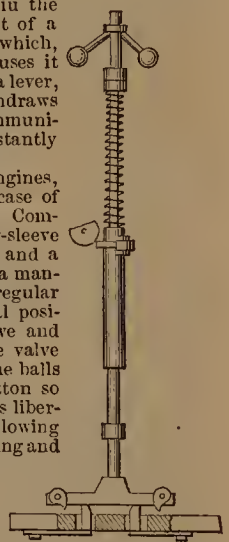
Fig. 5895 shows a set of devices designed to stop the loom when the weft-thread breaks or gives out; in this case the bars of the grid on the lay are allowed to pass the weft-fork, and a lever is thus allowed to drop so low as to be struck by the wiper *K*, which pushes it and the bar forward until the shoulder strikes a lever, and by the interveution of another lever unlocks the shipper.

Stop-motions are also used in *roving*, *spinning*, and *working machinery*. See Fig. 5900.

The stop-motion of *drawing*-machines is contrived to arrest the motion of the machine when a sliver breaks. This is accomplished by causing the slivers from the finishing carding-engine to pass over weighted guide-levers, termed *spoons*, mounted so as to be capable of turning upon centers, and kept in a certain position by the tension of the fibers while being drawn. Should one of the slivers break, or a can become empty, the spoon falls, and a part projecting from its under side intercepts the motion of a vibrating bar, and this acts upon other apparatus which shifts the driving strap from the fast to the loose pulley. See STOPPING MECHANISM.

The electric stop-motion for fabric-machines is so arranged that, on the breaking of a single thread, the emptying of a bobbin, the accidental bending of a needle, or on holes being caused in the work by the knotting or thinning out of a thread, an electric circuit is completed, which, passing through an electro-magnet, causes it to attract an armature, and so releases a lever, which, actuated by a strong spring, withdraws a clutch through which motion is communicated to the loom, and the machine is instantly stopped.

Fig. 5896.



*Stop-Motion for Engine.*

Fig. 5896 is a stop-motion for steam-engines, to come into action automatically in case of the failure or breakage of the governor. Combined with the governor is a coupliug-sleeve with a dog let in crosswise of the same, and a supporting-spring and button in such a manner that when the engine runs at its regular speed and the balls occupy their normal position, the connection between the valve and governor-rod is not disturbed, and the valve remains open; but if from any cause the balls drop down, the dog will strike the button so that it is thrown back, and the sleeve is liberated from the rod of the governor, allowing the same to follow the action of the spring and close the valve, and thus stop the motion of the engiue.

**Stop'per.** 1. (*Nautical.*) A short piece of rope having a knot at one end, with a laniard under the knot; applied to shrouds, cables, etc., for various purposes.

*a. Of the anchor;* a rope attached to the cathead, and, after passing through the anchor-ring, made fast to a timber-head.

*b. Of the cable;* a *deck-stopper* is a rope attached to a ring on the deck, and lashed to the cable to prevent the veering of the latter. The cable-stopper has a hook and thimble at one end, and a laniard at the other.

A *dog-stopper* is clinched around the mainmast and secured to the cable.

A *wing-stopper* is clinched to a beam.

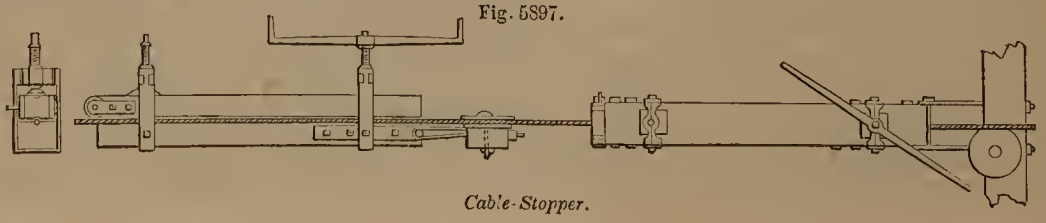
A clamp or stopper is used to secure a cable while *fleeting* it on the capstan, especially in hoisting heavy weights.

The illustration shows the stopper by which the rope was clamped when hoisting the chains of the Menai Suspension Bridge. One end of the chain was carried over the strait, and attached to that which hung perpendicularly from the opposite pier. The hoisting power was 4 capstans, each worked by 32 men, and assisted by powerful tackle. Each chain weighed 242,299 pounds, over 121 tons. As the rope coiled upon the capstan, it was nccessary to *fleet* it back every 3 rounds, and the stopper was to prevent the fall of the rope from surging back. See also CABLE-STOPPER.

*c. Of rigging;* a rigging-stopper secured to standing rigging above and below an injured part, so as to make the piece secure. It may be done by lashing dead-eyes to each part, and then hauling taut by laniards.

*d.* A piece of rope with a knot at one end and a hook at the other, for various purposes about the deck.

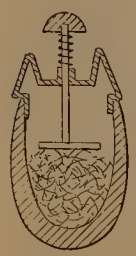
Fig. 5897.



*Cable-Stopper.*

2. (*Railway Engineering.*) A trailing-brake formerly used on inclined planes. It was in the rear of the last wagon in ascending, and was thrown into action by the pressure of the cars, if the rope broke. It penetrated the ground and stopped the descent. Also called a *trailer* or *eow*.

Fig. 5898.



*Tobacco Stopper.*

Fig. 5899.

*Bottle Stopper.*

3. A plug to condense tobacco in a pipe. Fig. 5898 shows a stopper attached to a spring-rod.

4. A cork or plug for closing a bottle. Many materials and forms have been used. See BOTTLE-STOPPER; FRUIT-JAR.

Fig. 5899 is Matthews's bottle-stopper for aërated liquids. It is of glass, with a gasket of caoutchouc, and was perhaps the first gravitating stopper longer than the internal diameter of the bottle, so that it cannot tip over.

The gasket may be compressed in one direction, but not in the other, so that it may be forced in, but not blown out.

**Stop'per-bolt.** (*Nautical.*) A large ring-bolt driven in the deck of a ship before the main-hatch, for securing the stoppers to.

**Stop'per-hole.** (*Puddling.*) A hole in the door of the furnace through which the iron is stirred, and the operation observed; it is sometimes stopped with clay: hence the name.

**Stop'ping.** 1. (*Mining.*) *a.* A door in a drift or gallery which *stops* the passage of air at a certain point, being a part of the artificial ventilation system of a mine.

*b.* Cutting down mineral ground with a pick.

2. (*Dental Surgery.*) Material for filling carious teeth. The holes are cleared of carious matter by instruments called *burs*, *excavators*, *drills*, *chisels*, etc. Among the filling materials may be cited: —

Gold.
Silver.
Tin.
Amalgams of silver, tin, or cadmium.
Os artificial: oxychloride of zinc mixed with a liquid.
Foil: gold or tin.
Hill's stopping: india-rubber and silex.

3. (*Engraving.*) Covering with varnish such parts of an etched plate as may have been sufficiently *bitten in* with acid; the remaining portions are then again exposed to acid to deepen the lines. See ETCHING.

4. Patching incomplete work with cement, such as gaps made by the spalling of marble or stone, of veneer, etc. *Badigeon.*

5. (*Farriery.*) A pad or ball occupying the space within the inner edge of the shoe, around the *frog* and against the *sole*. Its object is to keep the parts in a moist condition, similar to that which they possess in a state of nature, where the hoof is not lifted clear of the ground by a shoe, but the *sole* and *frog* come in contact with the damp earth and verdure.

Dickenson's English patent, some 50 years since, consisted in placing a piece of stout leather over the whole bottom of the foot, and nailing the shoe thereupon. An angular plate of iron is riveted to the outer surface of the leather, over the frog, whose form it imitates. Beneath the leather is packed a quantity of sponge which absorbs and retains moisture.

A common practice with horses habitually stabled, and where great care is exercised, is to stop the feet after coming from work, a composition of cow-dung and clay being used. Several devices for *stopping* the feet of horses have been suggested, and a number patented. Pads of india-rubber, felt, sponge, cork, etc.

**Stop'ping-brush.** 1. (*Hat-making.*) A brush used by hat-makers when working at the *battery*, to sprinkle boiling hot water upon the napping and the hat body to assist in uniting them as they are worked, pressed, and rolled by the hand, the *glove*, and the rolling-pin.

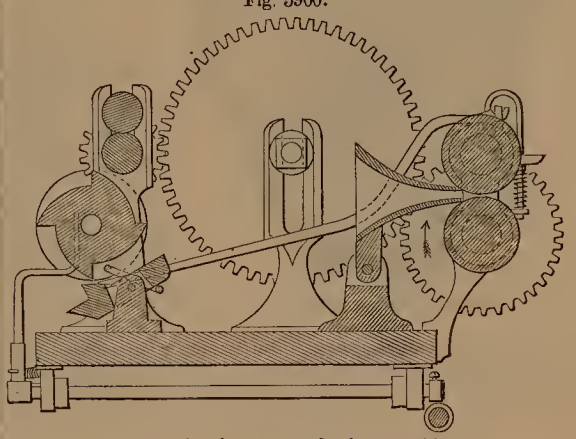
2. (*Engraving.*) A camel's-hair brush, used by engravers in *stopping* out portions of etched plates. See ETCHING.

**Stop'ping-knife.** The glazier's putty-knife.

**Stop'ping-mech'an-ism.** An automatic device in machinery by which the motion is stopped if a thread (for instance) should break. Automatic stopping-mechanisms are applied to looms to arrest the motion of the machine if the weft-yarn break or the shuttle be emptied; to spinning-machinery, if the roving or thread should break. See STOP-MOTION.

Fig. 5900 is a stop-mechanism for railway-heads of spinning-machines, designed to shift the belt and stop the machine when

Fig. 5900.



*Stop-Mechanism for Spinning-Machines.*

the sliver passing between the condensing or delivering rolls is above or below a given thickness. A rise or fall of the upper roller above or below a certain point moves a lever and raises a tripping-dog into contact with a ratchet-wheel.

**Stop'ping-off.** (*Founding.*) A term applied to the filling up with sand of a portion of a mold, when the casting is desired to be smaller than the pattern from which the mold is formed. It is in opposition to cutting out, when a portion of sand is removed, so as to enlarge the mold to represent an addition to the size of the pattern.

**Stop'ping-out.** (*Engraving.*) Covering with varnish any portion of an etched plate which has been corroded to a sufficient extent; after the *stopping-out*, farther portions are deepened by a repetition of the process called *biting-in*. See ETCHING.

**Stop'ping-up Pie'ces.** (*Shipbuilding.*) Timbers placed on the middle part of the *bilge-ways*, to meet and support the bottom of the ship. They form a part of the *cradle*.

**Stop-plank.** (*Hydraulic Engineering.*) One of a set of planks to occupy vertical grooves in the wing wales of a lock or weir, to hold back water in case of temporary disorder of the lock-gates.

**Stop'ple.** A stopper, cork, or bung, for a bottle, jar, keg, or cask. See STOPPER; BOTTLE-STOPPER.

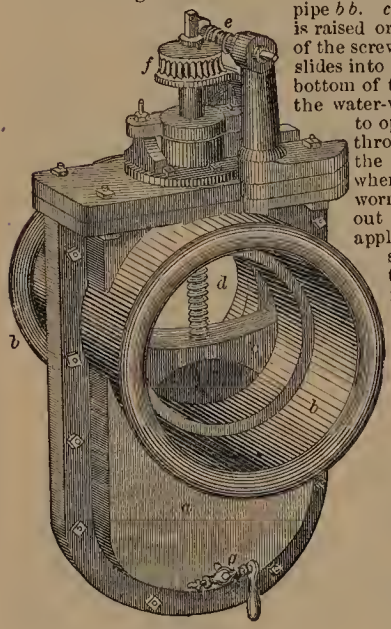
**Stops.** (*Nautical.*) The square projections or shoulders left on the outsides of the cheeks at the upper parts of the hounds.

**Stop-valve.** 1. (*Hydraulics.*) A valve which closes a pipe against the passage of fluid. The large valve used in water-mains is known by this name. It is usually a disk which occupies a chamber above the pipe when the passage-way through the latter is open, and is driven down by a screw to *stop* the aperture, its face being pressed against the seat by the contact of the rear with wedging abutments.

The smaller device, with a spigot, is called a STOP-COCK (which see). See also THREE-WAY VALVE.

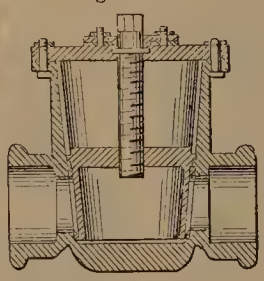
In Kearney's stop-valve for water-mains (Fig. 5901), the casing *a* has a circular opening for the ends of the supply-pipe *b b*. *c* is the valve, which is raised or lowered by means of the screw *d*. When open, it slides into the chamber at the bottom of the casing, leaving the water-way clear; in order to open it the worm *e* is thrown into gear with the worm-wheel *f*, and when it is started the worm may be thrown out of gear and power applied directly to the screw. This lessens the labor of opening and closing the valve under great pressure, and the opening being effected very gradually at first, avoids the danger of bursting the pipe by sudden pressure. *g* is a cock for drawing off or forcing out any foreign matters which may collect at the bottom of the valve-casing.

Fig. 5901.



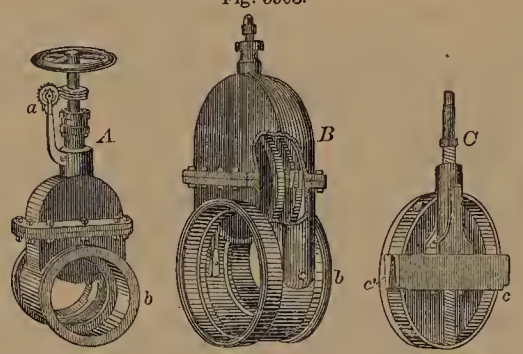

*Kearney's Stop-Valve.*

Fig 5902.



*McClelland's Stop-Valve.*

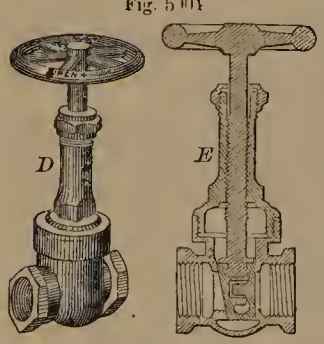
Fig. 5903.




*Stop-Valve.*

Fig. 5902 is the McClelland valve. It is a hollow cone, the hollow being of a diameter greater than the bore of the pipes. The body of the valve is cast upon and within bronze rings, which serve for bearings.

Fig. 5904



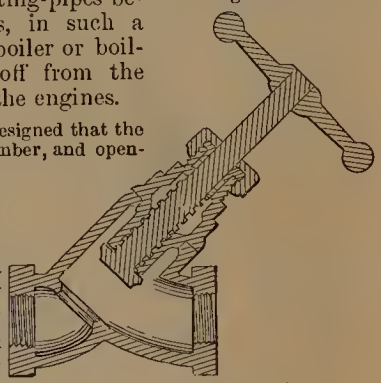

*Stop-Valve.*

Fig. 5903, *A*, *B*. The gate when raised is received in a box above the pipe-joint *b*. In *A*, the screw which operates the gate is turned by a hand-wheel, and an indicator *a* shows its position in the pipe. *B* has a double gate, shown at *C*, with one of the faces removed; when the gate is shut down, wedges within the casing *b* enter between the two wedges *c c'*, forcing the two faces against their proper bearing surfaces, to prevent leakage.

Fig. 5904, *D*, *E*. A perspective and section of a small stop-valve having a wedge-shaped valve, whose form renders it self-packing.

2. (*Steam-engineering.*) Stop-valves, or *communication*-valves, are fitted in the steam-pipes where they leave the several boilers, and in the connecting-pipes between the boilers, in such a manner that any boiler or boilers may be shut off from the others, and from the engines.

Fig. 5905.



*Stop-Valve for Steam-Enginery.*

In Fig. 5905, it is designed that the bore of the pipe, chamber, and opening in the valve-seat shall be the same.

**Stop-watch.** A watch in which the works (or a part of them) may be stopped by pressing in an exterior pin. Used in timing races, etc. The most improved form is the independent-seconds watch. See INDEPENDENT-SECONDS WATCH.

**Stop-work.** A device attached to the barrel of a watch, musical-box, or spring-clock, to regulate the winding of the spring and prevent over-winding. The middle turns of the spring are most equably efficient, and it is better to so organize the stop that the strongest and weakest powers of the spring be rejected. This is particularly necessary in watches destitute of the *fusee*, which is a conical wheel, whose office is to regulate the action of the *spring* on the *train*.

Fig. 5906.

*English Stop.* *Swiss Stop.*

**Storm-drum.** A signal. *a*. A painted canvas drum, distended by hoops.

*b*. A semaphoric device of Admiral Fitzroy, consisting of a hollow cylinder and cone, either of which, or both simultaneously, may be suspended from a mast or staff; their positions denoting the probable direction of the wind in an approaching storm. Thus: Cone point upward, to the right of the staff, northerly gale. Cone point downward, to the left of the staff, southerly gale. Cylinder above: expect dangerous winds from both quarters successively. Upright cone above cylinder: dangerous wind expected from north. Reversed cone below cylinder: dangerous wind expected from south.

Fig. 5907.

*Admiral Fitzroy's Storm-Signal.*

It took some time to inspire the sailors with confidence in the storm-signals of Admiral Fitzroy, but in 1864 it was found in England that fifty per cent, at least, of all the storm-warnings had proved correct, and in 1865 that seventy-three per cent had been fully verified. In France, during the years 1865, 1866, out of one hundred warnings sent, seventy-one were realized the first year, and seventy-six in the second year; and out of one hundred storms which occurred, eighty-nine were signaled during the first winter, and ninety-four during the second. The North German "Seewarte" mentions that out of thirty storm-waruings hoisted at Hamburg, ninety-four per cent were correct. The system in the United States is gaining the confidence of navigators, and is yearly growing more correct A number

of disastrous storms have been predicted with marvelous precision from Washington, and our daily weather-forecasts very seldom fail to express the general atmospheric conditions, and usually fore-announce the changes to within an hour or two of their occurrence.

Fig. 5908.

*Storm-Glass.*

**Storm-glass.** A tube containing a liquid holding a solution which is sensible to atmospheric changes. In clear weather the substance is said to settle near the bottom of the tube, the liquid remaining comparatively clear; previous to a storm the substance rises, causing the liquid to present a turbid and flocculent appearance. It is sometimes, as in the illustration, mounted on a back and associated with a thermometer. A thin bladder is tied over the top.

The solution is:—

| | |
|---|---|
| Camphor | 2 dr. |
| Niter | 1½ dr. |
| Sal. am. | 1 dr. |
| Proof spirit | 2¼ fluid oz. |

**Storm-kite.** A contrivance for sending a rope from a stranded vessel to the shore. An *anchor-ball* is frequently used from the shore to the vessel. See ANCHOR-BALL.

**Storm-pane.** A supplementary, framed sheet of glass, to substitute, in an emergency, for a broken pane in a light-house.

**Storm-pave'ment.** (*Hydraulic Engineering.*) The sloping stone paving which lines the sea-face of piers and breakwaters. The breakwater glacis.

**Storm-sail.** (*Nautical.*) A sail of reduced dimensions and extra heavy canvas, for heavy weather. Thus we speak of a *storm-jib*, *storm-trysail*, etc.

**Storm-sig'nal.** See STORM-DRUM.

**Sto'ry.** (*Architecture.*) The space between two floors of a building.

**Sto'ry-post.** (*Building.*) One occupied in supporting the *bress-summer* when a window occupies the whole front of the ground floor.

**Sto'ry-rod.** (*Building.*) A rod equal in length to the hight of the floor, and having the hights of the several steps of the stairs marked upon it.

**Stove.** 1. A close fireplace for warmth or cooking.

In Asia and some parts of Europe stoves are made of brick, or even of clay. In Germany they are frequently of tile, which is but a form of brick. In England and in the United States iron is preferred, though steatite (soapstone) is sometimes used. For burning hard coal, stoves are lined with fire-brick.

Stoves are made specifically for wood or for coal; they are also heated by charcoal, coal-oil lamps, or by gas, the construction being agreeable thereto. See HEATING-APPARATUS; HEATING-STOVE; FURNACE; and also under the various heads in the following list of stoves and heating appliances:—

Andiron.
Air-heater.
Air-stove.
Arnott's stove.
Asbestus-stove.
Ash-pit.
Athanor.
Autoclave
Bagasse-dryer.
Baker.
Balneum.
Banking-up.
Bark-stove.
Barrel-dryer.
Base-burner.
Base-burning furnace.
Base-burning range.
Base-burning stove.
Bath-furnace.
Bath-heater.
Battery.
Blower.
Blow-up pan.
Boiler. Domestic
Boiler. Steam
Boilery.
Bone-black retort.
Bookbinder's stove.
Brazier.
Broiler
Calcination.
Caliduct.
Calorifere.
Calorimeter.
Calorimotor.
Camp stove.
Car-heater.
Car-stove.
Carving-table.
Censer.
Chafer.
Chafing-dish.
Charcoal-furnace.
Check-bridge.
Chimney.
Chimney-cap.
Chimney-jack.
Chimney-valve.
Clinker-bar.
Coal-oil stove.
Coal-stove.
Cockle.
Coffee-pot.
Coffee-roaster.
Comb-pot.
Condenser.
Confection-pan.
Cooking-range.
Cooking-stove.
Corn-popper.
Coving.
Cowl.
Cresset.
Cross-bearer.
Crucible.
Cucurbit.
Cupel.
Cupola.
Curling-iron.
Damper.
Dead-plate.
Deflagrator.
Digester.
Dish-heater.
Draft.
Drum-stove.
Dryer.
Drying-house.
Drying-machine.
Dry-stove.
Dutch-oven.
Eccalobion.
Egg-boiler.
Electrical heater.
Elevated oven.
Evaporating-cone.
Evaporating-furnace.
Evaporating-pan.
Evaporator.
Feather-renovator.
Fender.
Fire-back.
Fire-bar.
Fire-basket.
Fire-box for locomotives.
Fire-brick.
Fire-bridge.
Fire-cage.
Fire-dog.
Fire guard.
Fireplace-grate.
Fire-pot.
Fire-screen.
Fire-top.
Fire-tube.
Firing-iron.
Flat-iron heater.
Flue.
Flue-brush.
Flue-cleaner.
Fluting-machine.
Foot-stove.
Foot-warmer.
Fruit-dryer.
Frying-pan.
Fumigator.
Funnel.
Furnace.
Furnace-grate.
Galley.
Gas blow-pipe.
Gas-heated furnace.
Gas-heater.
Gas-retort.
Gas-stove.
Gauffering-machine.
Glue-boiler.
Glue-pot.
Goose.
Grain-dryer.
Grate.
Grate-bar.
Grid.
Griddle.
Gum-pot.
Hastener.
Hearth.
Heat-engine.
Heating-apparatus.
Heating-furnace.
Heating-pipe.
Heating-stove.
Heat-regulator.
Hob.
Hot-air apparatus.
Hot-air furnace.
Hot-air stove.
Hot-flue.
Hot-house.
Hot-press.
Hot-wall.
Hot-water heating-apparatus
Hot-water pump.
Hot-well.
Hydrocarbon-furnace.
Hydrocarbon-stove.
Hypocaust.
Incubator.
Ironing-machine.
Kettle.
Kindler.
Lamp-stove.
Lard-boiler.
Laundry-stove.
Lumber-dryer.
Lumber-kiln.
Magazine.
Magazine-stove.
Malt-kiln.
Manure-desiccator.
Mercurial heater.
Muffle.
Norwegian stove.
Nursery-lamp.
Nut-roaster.
Oast.
Offal-dryer.
Oven.
Paint-burner.
Pan.
Petroleum-burner.
Petroleum-stove.
Plate-warmer.
Popper.
Portable boiler and furnace.
Portable furnace.
Portable stove.
Pyrometer.
Pyroscope.
Radiator.
Railway car-heater
Railway car-stove
Range.
Range-stove.
Reel-oven.
Reflector.
Regenerator.
Register.
Rendering-apparatus.
Reredos.
Reservoir-stove.
Retort.
Retort-stand.
Sad-iron.
Sad iron heater.
Salamander.
Saltern.
Sand-bath.
Set-pot.
Shovel.
Skillet.
Skimmer.
Slice.
Smoke-consuming furnace.
Smoke-house.
Smoke-stack.
Smoothing-iron.
Smoothing-iron heater.
Soap-boiler.
Soap-kettle.
Sorghum-evaporator.
Spark-arrester.
Spider.
Stack.
Stalk.
Steam-chest.
Steam-cooking apparatus.
Steamer.

Steam-heating apparatus.
Steam-kettle.
Steam-pan.
Steatite-stove.
Still.
Stove.
Stove-drum.
Stove-tank.
Stow.
Sugar-pan.
Teakettle.
Test. Fire
Thermal motor.
Thermal unit.
Thermetrograph.
Thermo barometer.
Thermo-electric pile.
Thermograph.
Thermometer.
Thermometric alarm.
Thermometric ventilator.
Thermo-multiplier.
Thermoscope.
Thermostat.
Thermotype.
Thimble.
Tinner's stove.
Tire-heater.
Toaster.
Unit.
Uptake.
Urn.
Vapor-burner.
Vapor-burning stove.
Ventilator.
Vulcanizing-flask.
Warming.
Warming-pan.
Water-back
Water-heater.
Wood-stove.
Wool-drying apparatus.

The *laconicum*, or heating-stove, used by the Romans in the fourth apartment of their Thermæ, was so called because introduced from Laconia. It sent forth a dry heat, and was of a cylindrical shape. It was placed in one of the angles of the apartment, and was heated by the flames of the *hypocaustum* beneath. It had a cupola, open at top, and the heat admitted from the *hypocaustum* was regulated by a brazen damper in the shape of a shield, according to Vitruvius, but of a globular shape in some cases, as in the baths of Titus, erected after the death of that useful compiler.

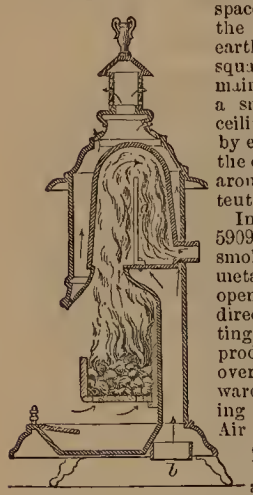
The apartment in which it was used was frequently called the *laconicum*, after the name of the stove.

The bathers here took their sweat, and then, after oiling themselves, plunged into the cold bath of the adjacent *frigidarium*. The heat of the stove modified the temperature of the adjacent *tepidarium*.

The *laconicum*, in some cases, was provided with niches, which were occupied by those requiring a dry bath. These niches were known as *sudationes*, or sweating-places.

Stoves on the Continent of Europe have a double casing which surrounds the fuel-chamber. Into the interval between the casings air is admitted from the outside of the building, and from this space the heated air is conducted to the room. The stoves are generally of earthenware, being made round or square, and are frequently constructed mainly of tiles. Some of them are like a small *hypocaustum*, in which the ceiling of the fuel-chamber is supported by earthen pipes, which conduct air to the chamber above. The fire is made around these pipes, heating their contents as well as the ceiling above it.

Fig. 5909.




*Stove.*

In the stove shown in section (Fig. 5909), the back and top of the fire and smoke-chamber are surrounded by a metallic drum. The fire-chamber is open in front, at once radiating heat directly into the apartment and admitting the air to support combustion. The products of combustion, after passing over a bridge *a*, are deflected downward and carried away by a flue passing through the back of the drum. Air from the apartment enters the drum through an opening *b* in its bottom, and, becoming heated, is again returned through apertures in its top. The combustion-chamber should, of course, be made perfectly fire and smoke tight.

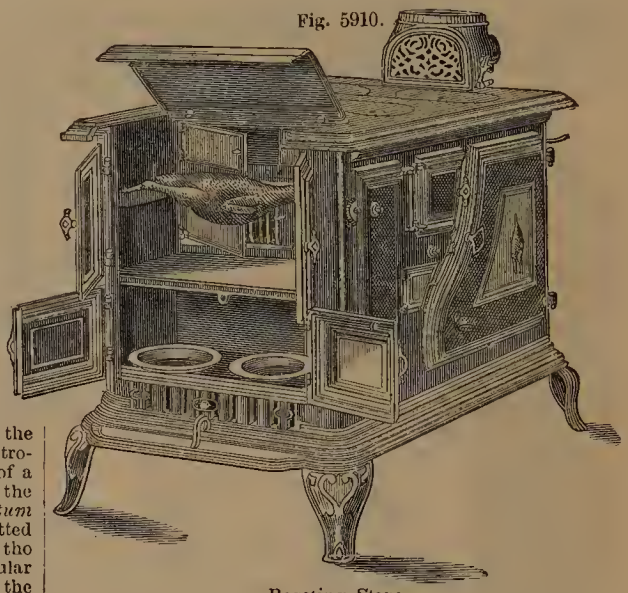
The stove, Fig. 5910, has a roasting-chamber at front, provided with doors, by opening which the meat may be exposed directly to the rays of the fire. Doors above allow the heated air from this chamber to pass into the flue.

The magazine-stove has been considered under several heads. The ATHANOR (page 175) is the earliest on record, having been used by the alchemists of the Middle Ages to keep up a constant fire, the fuel in the elevated chamber settling into the fire as that in the grate was consumed. It was thus a base-burner, though its magazine was not central, like the modern. A base-burner stove (*a*) was shown in 1685 at the fair of St. Germain, in France, by M. Delasme (Fig. 5911). See pages 242 and 2225.

The first magazine and base-burning stove of modern form was that of David Riz, English patent of April 28, 1770. It is shown at *b*, Fig. 5912. The fuel-reservoir has a cover, the stove is self-feeding, the grate is arched, the bottom layer of fuel only being permitted to burn. The heated products pass up outside the fuel-chamber to the chimney. Between this up-cast space and the outside of the stove is a chamber in which air is heated. The fuel is prevented, by the grated side of the fuel-chamber, from spreading laterally.

This latter feature is shown in Walker's English stove, 1842 (*c*, Fig. 5912), and Littlefield's, 1853, 1854 (Fig. 5913).

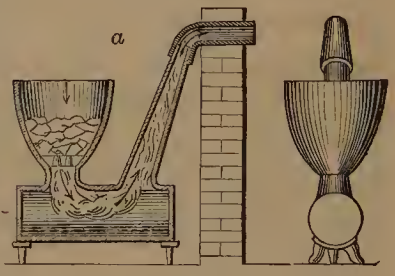
Fig. 5910.



*Roasting-Stove.*

Next to Riz may be cited the Watt patent of 1785 for a fuel-reservoir steam-boiler furnace, in which the base of the fuel only was directly exposed to combustion (Fig. 5914).

Fig. 5911.




*Delasme's Base-Burner* (1685).

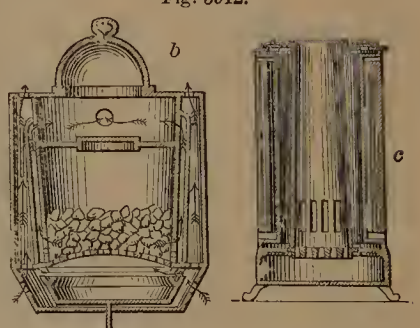
The first illuminated stove it would be difficult to determine, that is, one with mica windows, to enable the fire to shine through. The uses of mica are very ancient, the *lapis specularis* of Pliny being probably sheet-mica.

The first instance at hand occurs in the English patent of Pollok, 1807 (Fig. 5915). It is shown in two forms; one as a projecting door to an outstanding stove, and one as a fireplace-stove, with three mica windows.

Stratton, 1817 and 1822 (Fig. 5916), are other instances; the latter being much like James Watt's device.

Eliphalet Nott's stove, Schenectady, New York, in use before 1830, is shown at *i*, Fig. 5917. It was known as the *Saracenic grate*, probably in reference to the Athanor, or alchemist's stove, which has not passed entirely out of knowledge, although the writer has failed to find an illustration of it. Even the ordinary dictionaries recognize it, and it is described in Hebert's "Engineer's Cyclopædia," London, 1850, Vol. I. p. 109; Francis's "Dictionary of Arts"; Partington's Dictionary, 2 vols.; Weale's "Dictionary of Terms in Art."

Fig. 5912.




*Base-Burning Stoves.*
(*Riz*, 1770.) (*Walker*, 1842.)

The Nott stove was patented in England in 1830, 1831. It is a base-burning illuminated stove, without an internal fuel-chamber.

The Mott stove is shown at *j*, Fig. 5917, and had a suspended magazine, and mica doors to the fire-chamber.

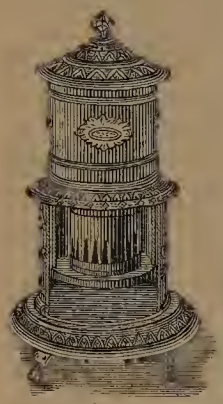
The Harper and Walker stove (*k*, Fig. 5917, English) of 1839 is a magazine base-burner, with a mica door to the fire-chamber.

The Walker stove of 1842 had a tall central magazine with grated openings at its lower portion.

The Cantelo stove (English patent) of 1846 (*l*, Fig. 5918) was made for keeping a constant heat in the inventor's *incubator*. It had a central magazine with lid.

Walker's French patent of 1849 (*m*, Fig. 5918) has the central magazine and mica door.

Fig. 5913.

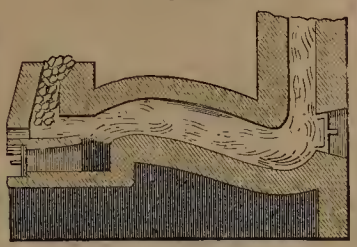


*Magazine-Stove.*
(*Littlefield*, 1853.)

Grant's English patent, 1850 (Fig 5919), has the magazine projecting into the fireplace.

Liddel in 1852 (*o*, Fig. 5920) shows a bulged combustion-chamber, a flaring fire pot, a sheet-iron outer cylinder, and a central magazine base-burner.

Fig. 5914.

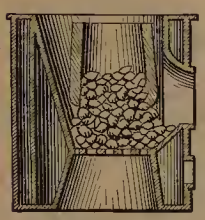


*Base-Burning Furnace.*
(*Watt*, 1785.)

He was the first to ventilate his magazines on top by allowing the gases to escape into the chimney.

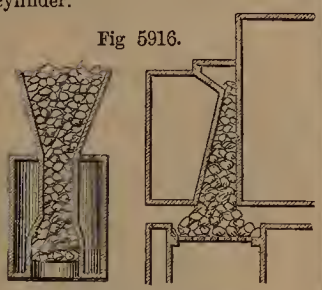
Littlefield, in 1853 (Fig 5913), had a grated fire-pot at the lower part of the magazine-cylinder.

Fig 5915.



*Mica-Front Stove.*
(*Pollok*, 1807.)

Fig 5916.

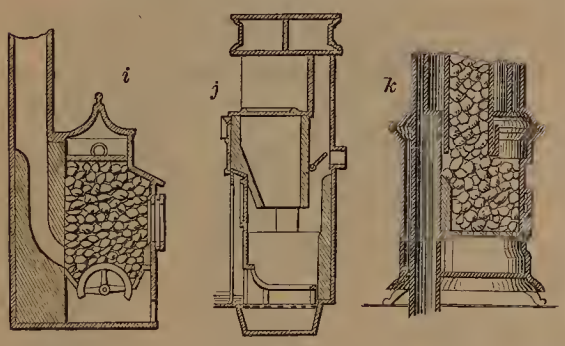


*Magazine-Furnaces.*
(*Stratton*, 1817 *and* 1822.)

Sexton, in 1856 (*p*, Fig. 5920), had a covered fuel-cylinder in the fire-chamber.

Cantelo's U. S. patent in 1859 (Fig. 5921) shows a petticoat fuel-cylinder projecting downward into the fire-pot.

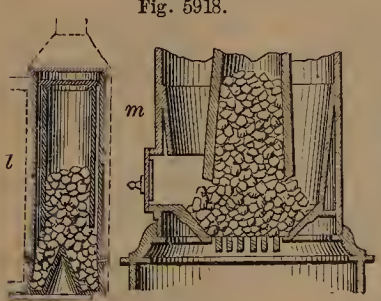
Fig. 5917.




*Magazine-Stoves*
(*Nott*, 1830.) (*Mott.*) (*Harper and Walker*, 1839.)

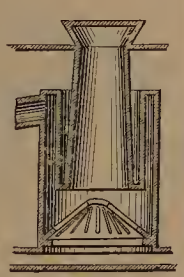
Roney, in 1861 (Fig. 5922), had a grated fire pot of larger diameter than his magazine.

Fig. 5918.



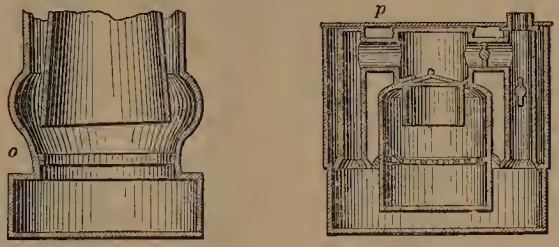

*Magazine-Stoves.*
(*Cantelo*, 1846.) (*Walker*, 1849.)

Fig. 5919.



*Base-Burner.*
(*Grant*, 1850.)

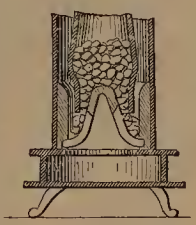
Fig 5920.




*Magazine-Stoves.*
(*Liddel*, 1852.) (*Sexton*, 1856.)

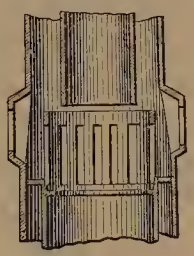
There are in the United States about 350 foundries engaged in the manufacture of stoves and furnaces, using annually 500,000 tons of iron. Of stoves alone it is estimated that the 275 foundries engaged in the business in 1871 produced 2,200,200 stoves. This, of course, does not include heating-furnaces. In 1830, the estimated number of stoves made in this country was 25,000; in 1840, 100,000; in 1850, 375,000; in 1860, 1,000,000; in 1870, 2,100,000, — valued at $37,600,000. The value of heating-furnaces annually made in the country will amount to $20,000,000.

Fig. 5921.



*Magazine-Stove.*
(*Cantelo*, 1859.)

Fig. 5922.



*Grated Fire-Pot Stove.*
(*Roney*, 1861.)

2. A room artificially heated to a high degree, as, —

The room in which scoured cloths are dried before *burling* and *fulling*.

The room in which packaged starch is dried.

In many trades, articles are artificially dried by a high heat, as bent wooden stuff; figures of plastic clay; crucibles; enameled or varnished metal-work, etc.

3. (*Founding.*) The usual contraction for the *drying-stove* for cores and molds.

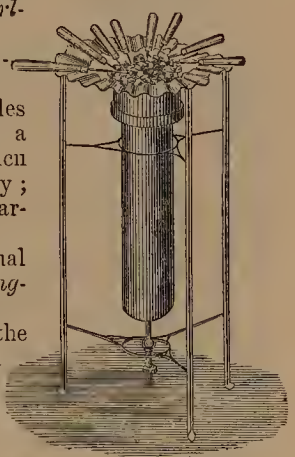
4. The *hot-house* of the florist. The furnace which heats the *forcing-house*.

5. (*Pharmacy.*) A chamber used in drying plants, extracts, etc.

6. (*Surgical.*) A heated dry-air bath. The *laconicum* or *calidarium* of the Romans.

A vapor bath. The *tepidarium* or *vaporarium* of the Romans.

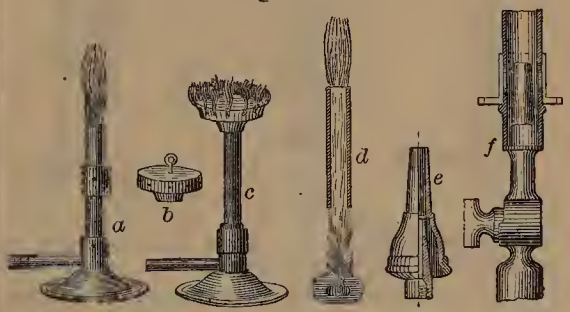
Fig. 5923.



*Bookbinder's Stove.*

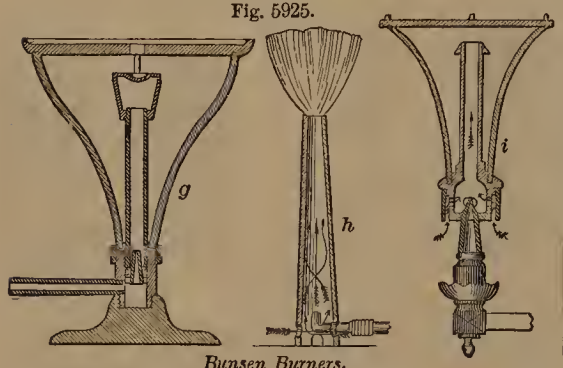
7. (*Bookbinding.*) A small gas-stove used for

Fig. 5924.




*Bunsen Burners.*

Fig. 5925.

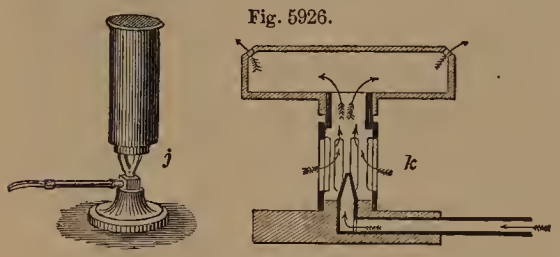



*Bunsen Burners.*

heating the tools with which the covers of books are lettered and ornamented (Fig. 5923).

**Stove-burn'er.** A gas-burner specially arranged for heating. The Bunsen burner is preferred, as it gives a blue, smokeless flame, with great heat. Its due performance depends upon the proper admixture of gas and air. If gas be in excess, the flame gives light and smoke and little heat. If air be in excess, the mixture explodes, and the gas takes

Fig. 5926.

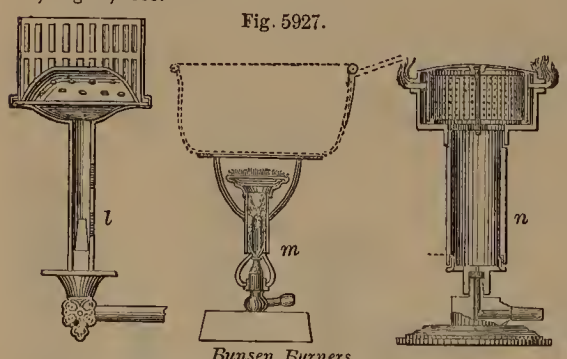



*Bunsen Burners.*

fire within the tube. See Griffin's "Chemical Handicraft," London, 1866, pages 96, 97. See also "Die Spectralanalyse," Schellen, Braunschweig, 1870, page 18.

Figs. 5924, 5925, 5926, 5927, show the mode of application, and several forms of the device.
*a*, from Griffin.
*b*, Rosette-burner (Griffin).
*c*, Rosette-burner (Griffin).
*d*, Bogart, 1867.
*e*, Allen; patent, September 7, 1869.
*f*, Bradley, 1865.
*g*, McGlensey; patent, June 19, 1860.
*h*, Osmond; patent, March 14, 1865.
*i*, Griswold, 1868.
*j*, Bloxam's "Chemistry"
*k*, Webb and Parkin, 1871.
*l*, Lazear and Sharp, 1868.
*m*, Hamilton; patent, April 26, 1870.
*n*, Bogart, 1866.

Fig. 5927.



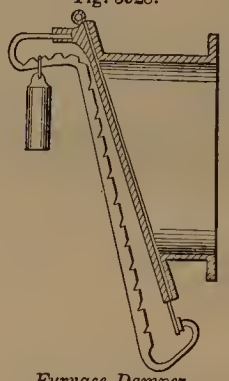

*Bunsen Burners.*

**Stove-damp'er.** A shutter or valve to regulate the size of an opening at which air is admitted to a stove, or at which smoke passes off. See DAMPER.

Fig. 5928 shows a hinged damper applied to the draft-hole of a furnace. The in-rushing air tends to close it, the gravity of the damper and the slip-weight to open it. By adjusting the position of the slip-weight, the quantity of air admitted to the fire can be regulated.

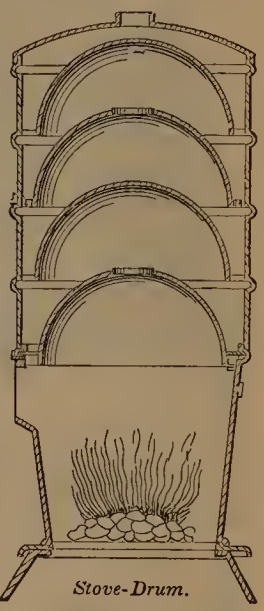
**Stove-drum.** A chamber above a stove in which the heated products are dis-

Fig. 5928.



*Furnace-Damper.*

Fig 5929.

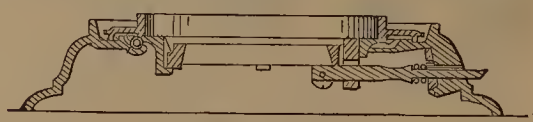


*Stove-Drum.*

seminated, in order that their heat may be more perfectly abstracted.

In Fig. 5929, the caloric current is deflected by domed plates, each alternate one having an aperture in the apex, and all having passages around their sides. The side passages of the centrally perforated deflectors are governed by an annular register-damper. See DRUM.

Fig. 5930.

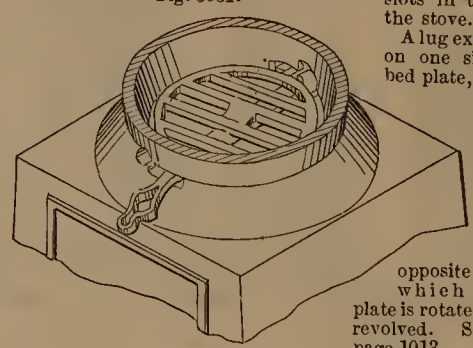


*Shaking Stove-Grate.*

**Stove-grate.** The grid or series of bars on which the fuel rests in a stove.

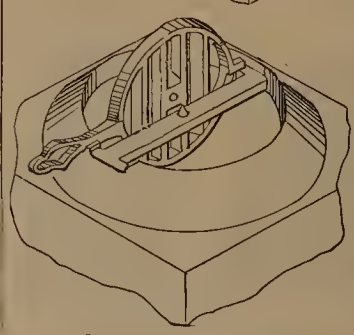
Fig. 5930 shows a shaking grate in which the bed-plate rests on balls moving in slots in the base of the stove.

Fig. 5931.



A lug extends down on one side of the bed plate, to which one end of the grate is pivoted, while the other is supported by an arbor in a loop on the opposite side, by which the bed-plate is rotated and grate revolved. See GRATE, page 1013.

Fig. 5931 is a grate which may be shaken horizontally about its axis to remove the ashes, or may be tilted into a vertical position to dump the spent fuel into the ash-pit.



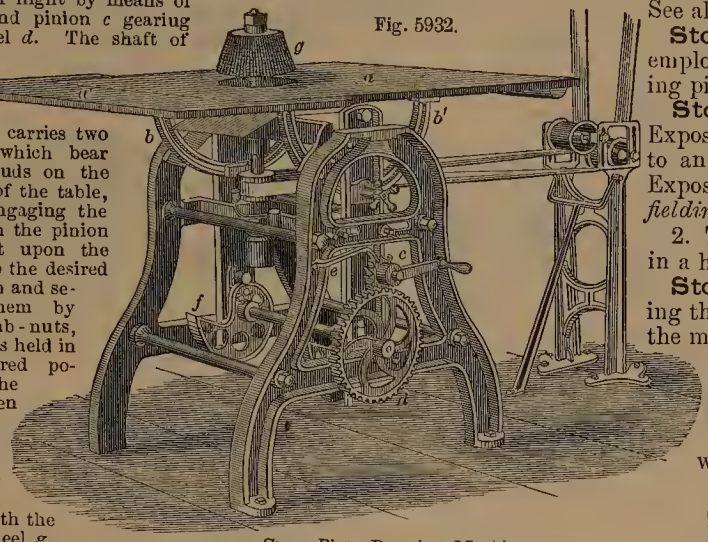
*Dumping Stove-Grate.*

**Stove-plate Dressing-machine'.** A machine for dressing off the edges of stove-plate castings, so as to form tight joints,

smoothing out the interior of the holes, etc. The operation is far neater and more rapid than filing.

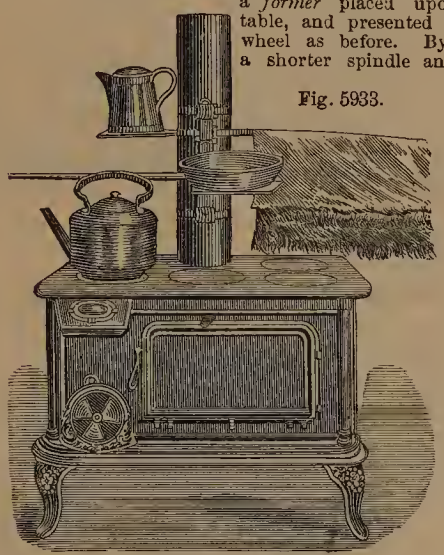
The casting is placed upon the table *a*, which is adjusted to the proper hight by means of a lever and pinion *c* gearing in a wheel *d*. The shaft of this wheel carries two cams *f*, which bear against studs on the uprights of the table, and by engaging the dog *e* with the pinion turning it upon the axis *b b'* to the desired inclination and securing them by two thumb-nuts, the table is held in the required position. The plate is then carried around with its interior edge in contact with the emery-wheel *g*, rapidly rotated by a pulley on its upright shaft, polishing this part of the plate. For dressing the outside edges, an additional table *a'* secured to the front of the main table is used. The plate is laid upon a *former* placed upon this table, and presented to the wheel as before. By using a shorter spindle and cup-shaped wheel, the machine may be employed for surface-grinding.

Fig. 5932.




*Stove-Plate Dressing-Machine.*

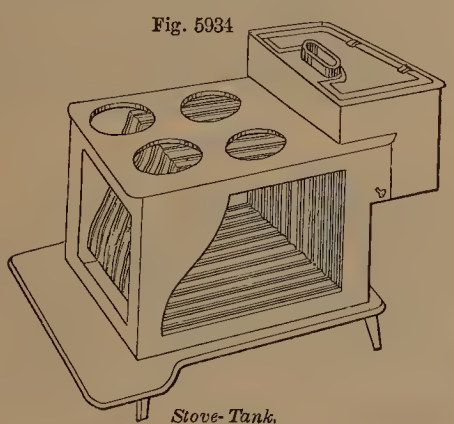
Fig. 5933.



*Stove-Shelf.*

**Stove-shelf.** An attachment to a stove to hold vessels, cloths, and what not. It has a collar encircling the stove-pipe, and is hinged, so as to project in any desired direction.

Fig. 5934



*Stove-Tank.*

**Stove-tank.** A reservoir attached to a stove. See also Figs. 4268, 4269.

**Stove-truck.** (*Founding.*) A truck employed in cannon-foundries for moving pieces of ordnance.

**Stov'ing.** 1. (*Vinegar-making.*) Exposure of *malt-wash* (*gyle*) in casks, to an artificial heat in closed rooms. Exposure in the open air is termed *fielding*.

2. The exposure of printed fabrics in a heated room to fix the color.

**Stow.** A raised structure containing the furnace and set of pots used in the manufacture of tin-plate. The pots are arranged in a series of five, — *tin-pot*, *wash-pot*, *grease-pot*, *pan*, *list-pot*. See TIN-PLATE.

**Stow'board.** A place into which rubbish is put.

**Stowce.** (*Mining.*) *a.* The *drawing-stowce* is a small windlass.

*b. Stowces.* Pieces of wood of particular forms and constructions placed together, by which the possession of mines is marked; a pair of *stowces* possess a *mear* of ground.

**Stow'ing.** (*Mining.*) Rubbish (*attle*) put into old workings (*goafs*) to fill them up.

**Stra-bis'mus-for'ceps.** A straight or curved pinchers, with fine rat-tooth extremities for holding the muscles to be divided in correcting strabismus.

The operation for strabismus was first performed by Diffenbach in 1839, by dividing one of the six small muscles which rotate the eye.

Fig. 5935.

*Strabismus-Forceps.*

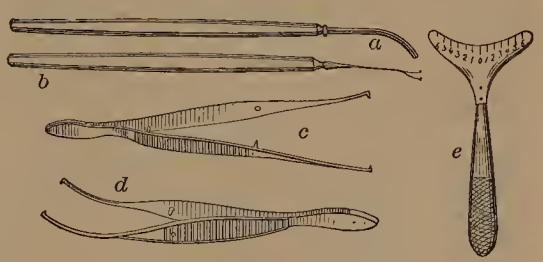
**Stra-bis'mus-in'struments.** (*Surgical.*)

*a*, half-curved strabismus-hook.
*b*, strabismus double-hook.
*c*, straight strabismus-forceps.
*d*, curved strabismus-forceps.
*e*, strabometer. See also SCISSORS.

**Stra-bis'mus-scis'sors.** Scissors with straight or curved blades, for dividing the contracted muscles causing strabismus.

**Stra-bom'e-ter.** (*Surgical.*) An instrument for measuring the want of concordance of the optic axes. See *e*, Fig. 5936.

Fig. 5936.



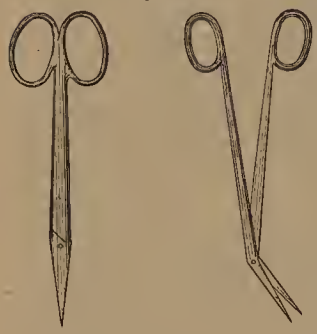

*Tiemann's Strabismus-Instruments.*

**Stra'bo-tome.** (*Surgical.*) A knife for operating for strabismus.

**Strad'dle-pipe.** (*Gas.*) A bridge-pipe connecting the retort with the hydraulic main. The lower figure shows one usual form, in which the eduction end of the pipe dips below the surface of the water in the hydraulic main. See DIP-PIPE.

The upper figure is an improved form, in which the trap is formed in the head of the pipe without the necessity of carrying its exit aperture down into the hydraulic main.

Fig. 5937.



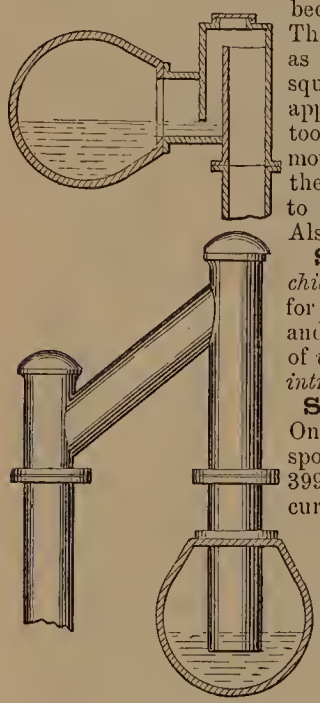
*Strabismus-Scissors.*

**Strad'dle-plow.** A plow with two triangular, parallel shares, a little distance apart, and used for running on each side of a row of dropped corn, to cover the seed.

**Strad'dling.** (*Vehicle.*) Applied to spokes when they are arranged alternately in two circles in the hub. Also said to be *staggered.*

**Strag'gling.** (*Stone-working.*) The process of working down the face of a grindstone to a regular shape, or of removing metallic particles which have become imbedded therein. The grindstone is turned as usual, while a ¼-inch square piece of soft iron is applied to it as a turning-tool, a rocking or wriggling motion being imparted to the iron, which causes it to bite upon the stone. Also known as *ragging.*

Fig. 5938.



*Straddle-Pipe.*

**Straight-arch.** (*Architecture.*) A kind used for the heads of doorways and windows. It is formed of *voussoirs,* but has a level *intrados.*

**Straight-arm Pul'ley.** One with radial arms or spokes, like *m l n,* Fig. 3999, page 1819, and not curved like that at *v,* same figure.

The straight-armed pulley can be made with the least possible metal and the greatest possible strength for the metal. Its form is the best able to transmit the peculiar strains brought to bear upon it, and at the same time it is the most pleasing form to the eye.

Pulleys must be high on face for a belt not shifting, and straight on face for a shifting belt. A pair of fast and loose pulleys require that both pulleys should have faces high in center.

**Straight-edge.** A strip of metal or wood of proved rectitude, used to test the flatness of a surface or the straightness of an edge.

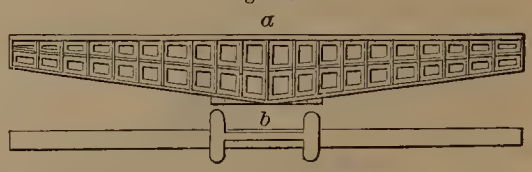
By a combination of 3 straight-edges, their absolute truth or incorrectness may be established; being tried in three binary combinations and shifted end for end and top and bottom, no fault common to them all can escape notice.

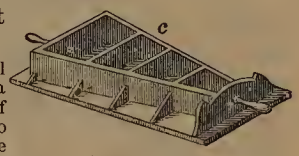
In Fig. 5939, *a b* is an elevation and top view of one of Whitworth's long straight-edges; these are from 6 to 10 feet or more in length, made of cast-iron, and ribbed at the back to prevent flexure of the fiducial edge.

*c* is a surface-plate, for verifying plane-surfaces. See PLANE-SURFACE, page 1726.

**Straight'en-ing-ma-chine'.** (*Metal-working.*) One for taking the twist or bend out of rails, shafting, bars, rods, and tubes; or the kink and bend out of hoop-iron or wire; or the buckle out of plates.

Fig. 5939.

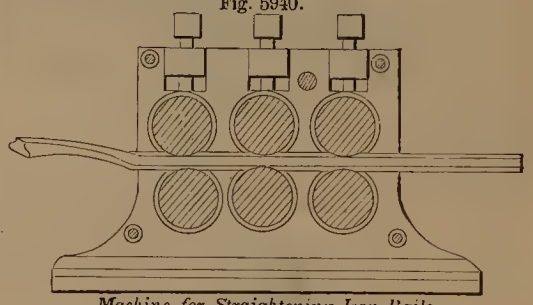



*Straight-Edge.*

Fig. 5940 is a railway-rail straightener. It consists of a suite of three or more pairs of rolls, each pair being grooved to correspond in size and shape with the rail to be straightened. The rolls are so arranged that the grooves of the several pairs are perfectly in line, by means of which the rail, after having entered the groove of one pair, will be drawn through and made to enter successively the grooves of the second and third pairs.

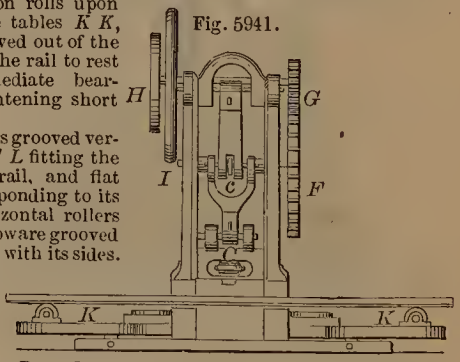
Fig. 5940.



*Machine for Straightening Iron Rails.*

In Fig. 5941, the sliding press-drop *C* is operated by a toggle-joint *c,* whose central pin is connected to a crank by which it is actuated. The toggle-joint crank is operated by gear-wheel *F* and pinion *G,* driven by pulley *H*; *I* is a fly-wheel. The rail is supported on rolls upon the vibratable tables *K K,* which are moved out of the way to allow the rail to rest upon intermediate bearings in straightening short bends.

Fig. 5941.




*Drop-Press for Straightening Railroad-Rails.*

Fig. 5942 has grooved vertical rollers *I' L* fitting the head of the rail, and flat rollers corresponding to its bottom; horizontal rollers above and beloware grooved to correspond with its sides. As it passes between these its curvatures are rectified.

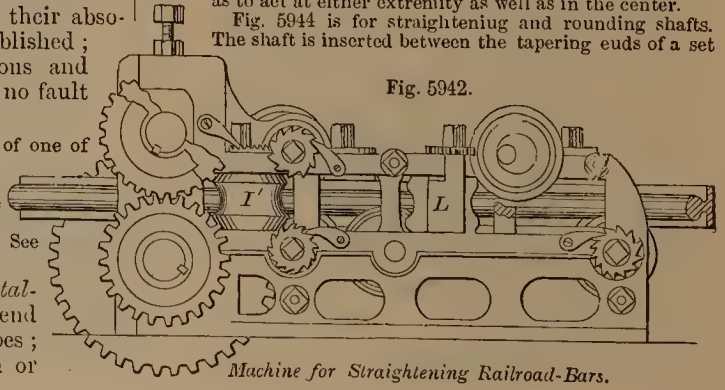
See also patents: —

Anderson, Au 29, 1848. 85,917. Downing, Jan. 19, 1869.
39,876. Bolton, Sept 15, 1863. 124,867. White *et al.*
47,208. Johnston, Apr 11, 1865. March 19, 1872.
62,669. Nelson, March 5, 1867. 125,055. Knizel, March 26, 1872.

Fig. 5943 is for straightening shafts or bending iron of round or other section. The shaft is supported on two rests, and pressure applied by means of a lever and screw mounted on a carriage, which may be traversed on the bed of the machine, so as to act at either extremity as well as in the center.

Fig. 5944 is for straightening and rounding shafts. The shaft is inserted between the tapering ends of a set

Fig. 5942.

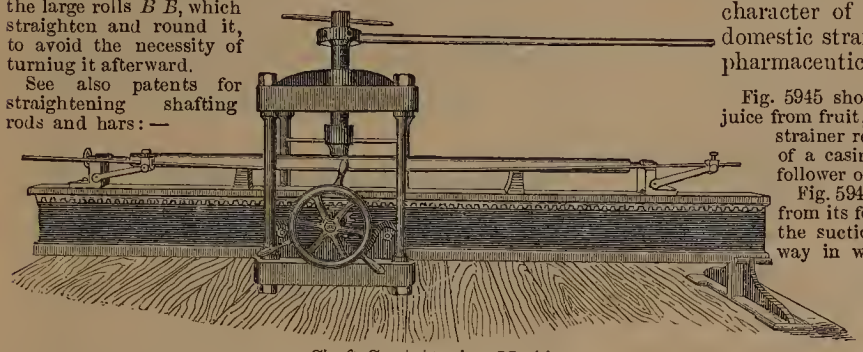



*Machine for Straightening Railroad-Bars.*

of guide-rolls *C*, is fed forward by the obliquely arranged feed-rolls *a' b c*, journaled in pieces *f f f*, adjustable by screws, and passes between the large rolls *B B*, which straighten and round it, to avoid the necessity of turning it afterward.

See also patents for straightening shafting rods and bars: —

Fig. 5943.

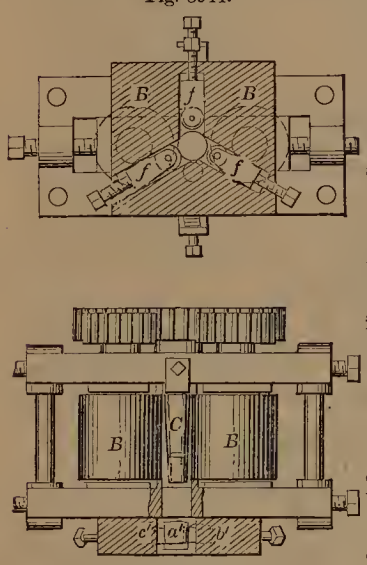


*Shaft-Straightening Machine.*

| | | | |
|---|---|---|---|
| 41,306. | Lauth...Jan. 19, 1864. | 93,256. | Warr...Aug. 3, 1869 |
| 42,051. | Sellers..Mar. 22, 1864. | 102,916. | Cheney, May 10, 1870. |
| 60,260. | Safely....Dec. 4, 1866. | 128,335. | Tasker, June 25, 1872. |
| 65,242. | Lander..May 28, 1867. | 149,065. | Robertson, March 31, 1874. |
| 65,832. | Reese...June 18, 1867. | 155,760. | Seaman, Oct. 6, 1874. |
| 76,781. | Lafarge *et al.* April 14, 1868. | | |

The straightening of metallic plates is performed with the hammer or by rolling. In the former case the work is the reverse of that of *raising*, in which the plate is stretched at the center and caused to assume a concave form. In straightening, each cockle or protuberance is treated as a rise, which is to be obliterated by an equal tension upon or stretching of all other parts, resulting in a plane.

Fig. 5944.



*Machine for Straightening and Rounding Shafting.*

In straightening by the roller, the plate is passed twice between the rollers, each side alternately upward, and is bent in each trip to the limit of its elasticity; the result, under favorable circumstances, is to reduce all outlying irregularities and reduce it to a plane

This is similar in principle to the action in wire-straightening.

The practice as to thick and thin plates differs, as it is possible, with a thick plate, to stretch the concave side of a protuberance to such an extent as to balance the tension or stretched condition of the convex side, and thus make a plane. The blows of the hammer are delivered inside the concavity.

See also patents: —

40,899, Bell, December 15, 1863 (angle-iron and bars).
30,322, Hughes, October 9, 1860 (hoop-iron).
111,941, Hunter, February 21, 1871 (bolts)
125,892, Hammer, April 23, 1872 (cylinders).
125,996, Walkin, April 23, 1872 (tubing and bars).
152,095, Scofield, June 30, 1874 (tubing and bars).

See also WIRE-STRAIGHTENER.

**Straight-joint.** 1. A joint which does not curve or depart from a straight line.

2. Said of the junction line of flooring boards when the joints at the butting ends of the boards form a continuous line.

**Straight-line Chuck.** A peculiar chuck fitted to a rose-engine when the patterns are required to follow a straight instead of a curved direction.

**Straight-of-breadth.** (*Shipbuilding.*) That part of a vessel where her cross-sections are vertical at the sides.

**Straight-stall.** (*Mining.*) An excavation made into the thick coal, having the solid coal left on three sides of it.

**Strain'er.** A device partaking of the character of a *sieve* or of a *filter*. The domestic strainer is like the former; the pharmaceutical, like the latter.

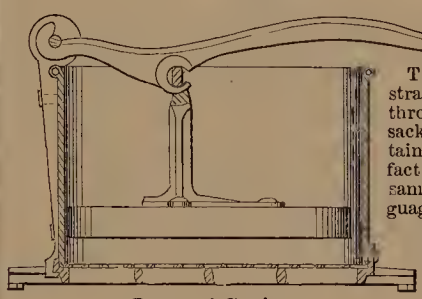
Fig. 5945 shows a domestic filter for pressing juice from fruit, water from vegetables, etc. The strainer rests upon a grating in the bottom of a casing, and articles are pressed by a follower operated by a lever. See FILTER.

Fig. 5946 is a *mushroom-strainer*, so called from its form. It screws on to the end of the suction-pipe of the pump. From the way in which the water enters, it is decanted, as it were, not disturbing the sediment on a lower level.

The *Hippocrates sieve* is a simple and very ancient form of filter. It may be made by folding diagonally a square of flannel or muslin and sewing it along the meeting edges, so as to make it of a funnel shape.

Another form is a pouch, made by uniting the opposite angles of a square piece of cloth.

Fig. 5945.



*Press and Strainer.*

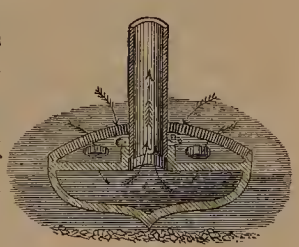
The Romans strained their wine through a bag or sack (*saccus*). We retain the word. In fact, it is about the same in all languages. See SACK.

**Strain'ing.** (*Saddlery.*) A piece of canvas or leather, which, being drawn tightly over the *tree*, forms the foundation for the *seat* of the saddle.

This is covered by *cross-straining*, the *ground seat*, the *set* or *filling*, and the latter by the *top-seat*.

It is called the straining, because the *stretch* is taken out of it by repeated *wettings* and *stretchings*.

Fig. 5946.



*Suction-Pipe Strainer.*

**Strain'ing-beam.** The piece situated between the upper end of the *queens* of a frame to resist the thrust of the rafters. See ROOF; QUEEN-POST.

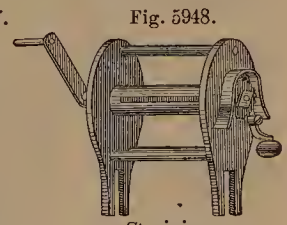
The *straining-sill* is at the feet of the queen-posts.

**Strain'ing-fork.** (*Saddlery.*) A tool used in straining the webbing over saddle-trees. The prongs pass through the webbing and catch against the tree, the tool being used as a lever to strain the damp webbing as tightly as possible while it is secured by tacks.

Fig. 5947.

*Straining-Fork.*

Fig. 5948.



*Straining-Reel.*

**Strain'ing-leath'er.** (*Saddlery.*) A kind of web forming the seat of a hussar-saddle.

**Strain'ing-reel.** (*Saddlery.*) A tool for *taking the stretch out* of webbing before putting it on the tree, as a foundation for the saddle-seat.

**Strain'ing-sill.** (*Carpentry.*) A piece of timber

on the *tie-beam*, between the feet of the *queen-posts*, to hold them against the thrust of the struts. See QUEEN-POST.

**Strake.** 1. (*Shipbuilding.*) A continuous line of planking or plates on a vessel's side; reaching from stem to stern.

*Wales*, in merchant-vessels, are strakes below the *sheer-strakes*.

*Sheer*-strakes are those between the main-deck ports and the *plank-sheer*, which rests on the top timbers of the frame.

*Channel-wales* (*in two-decked ships of war*) are the strakes between the ports of the lower and main decks. In three-deckers, they are those between the middle and main-deck ports.

*Middle-wales* (*in three-deckers*) are the strakes between the gun-deck ports and those of the middle deck.

The planking between the ports, fore and aft, is called *short-stuff*.

The *main-wales* are four strakes of planking, or the corresponding breadth of plating immediately below the *black*-strake.

The *black*-strake is the one next below the lower or gun-deck ports.

The *bilge*-strakes are upon the broad and flatter portion of the vessel's bottom.

The *garboard*-strake is next to the keel.

The *limber*-strakes are a part of the inner skin, and are next to the keelson, from which they are separated by spaces called the *limbers*, which are passages for bilge-water, and covered by movable boards.

The other portions of the inside skin are the *ceiling* or *foot-waling*.

The strakes immediately below the *shelf-pieces* which support each tier of deck-beams are called *clamps*.

A *binding*-strake is a longitudinal plank half notched into the beams of a ship. Sometimes called a *letting-down* strake.

A *sheer*-strake (in a boat) has its upper edge flush with the top of the gunwale, and its lower edge overlapping the *landing*-strake.

A *landing*-strake is that immediately below the gunwale.

The *binding*-strake is next below the *landing*-strake.

A *wash*-strake is above the gunwale, and is removable.

Strakes are divided by *seams*.

The *joints* formed by *planks* in a *strake* are called *butts*.

2. (*Mining.*) An inclined trough for separating ground ore according to gravity, by means of a flow of water. A *launder*. The process is known as *tying*.

3. (*Vehicle.*) A band on the fellies; in sections, and not continuous like a tire.

**Strand.** An assemblage of several twisted yarns wound together. Hemp is twisted into a *yarn;* and several of the latter are twisted together, or, as it is called, *laid up* into a rope. Three strands thus laid are said to be *hawser-laid*, the twist being the reverse of the individual yarns. Four strands thus twisted constitute the *shroud hawser-laid*.

**Strap.** A band of leather or metal forming a fastening.

Fig. 5949.

*Lock-Strap.*

1. (*Nautical.*) *a.* One of the rudder bands, which also holds a *pintle*, which hooks into an *eye* on a *brace* bolted to the stern-post.

Fig. 5950.

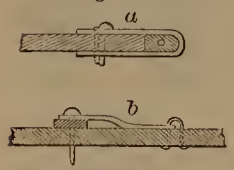
*Strap.*

*b.* A band of rope or metal around the *shell* of a tackle-block, by which its *hook*, *eye*, or *tail* is attached thereto.

2. (*Carpentry.*) A band of iron around a beam at a scarf-joint or elsewhere. See some of the instances in Fig. 4660, SCARF.

3. (*Machinery.*) A band over the end of a rod to hold a connecting-pin or wrist. The example has a key and wedge to tighten the parts together.

Fig. 5951.




*a*, *Rod-Strap.*
*b*, *Hammer-Strap.*

4. (*Vehicle.*) *a.* A plate on the upper side of the tongue and resting upon the double-tree, to assist in holding the wagon-hammer.

*b.* A clip, such as that which holds the spring to the spring-bar or to the axle.

*c.* The stirrup-shaped piece of a clevis.

5. (*Harness.*) A leathern thong, provided with a buckle, by which separate parts of a set of harness are connected together.

6. (*Wear.*) A slip of leather or cloth to fasten a boot, a valise, or trunk; used in connection with a buckle. A girth or band around a trunk or package, such as a rolled shawl, blanket, or coat.

Fig. 5952.

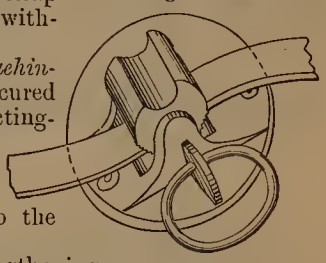
*Strap-Block.*

7. A piece of leather with fine emery or polishing-powder, to sharpen a razor or knife. A *strop*.

**Strap-block.** (*Nautical.*) A block with a strap around it, and an eye worked at the lower end for attachment to a hook upon deck for a purchase.

**Strap-clamp.** A device to hold a hitching-strap. The cam, being free to turn upon its pivot, bites the strap and holds it firmly when it is pulled upon in either direction. By holding the cam in its middle position, the strap may be inserted or withdrawn.

Fig. 5953.



*Strap-Clamp.*

**Strap-head.** (*Machinery.*) A journal-box secured by a strap to a connecting-rod. See STRAP, 3.

**Strap-hinge.** One with long flaps, by which it is secured to the door and post.

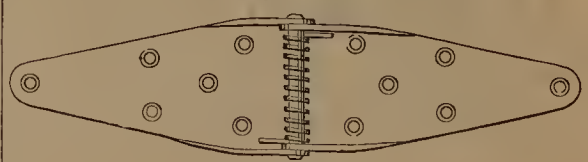
Fig. 5953 has strengthening-lips, and a spring on the pintle.

**Strap-joint.** (*Machinery.*) A connection by strap, key, and gib, as on the end of a pitman. See STRAP.

**Strap'ping-plate.** (*Mining.*) One of the straps or bands which bind the connecting rods to each other at the points where they are scarfed together.

**Strass.** 1. (*Glass.*) Fr. *Strasse*. Named from its German inventor. A pellucid glass used in the manufacture of artificial gems. It contains a large quantity of oxide and borate of lead. It is easily fused, is soft and very refractive.

Fig. 5954.



*Strap-Hinge.*

2. (*Silk.*) The refuse of silk in the process of working into skeins.

**Stra-tom'e-ter.** An instrument for determining in what manner geological strata press upon each other. *Mayne.*

**Straw.** 1. The stalk of wheat or other small grain; or of some descriptions of grass. The principal use of this material in the industries of this country and Europe is in *thatching*, *plaiting*, and *paper-making*.

2. (*Mining.*) A fine straw filled with powder, and used as a fuse.

**Straw-board.** Thick paper-board made altogether or principally from straw; usually that of wheat or rye.

The first process consists in boiling the straw with quicklime, in a wooden digester, which takes steam from a boiler. The

straw is packed in layers with lime betweeu them, and the whole boiled for from 10 to 12 hours, according to eireumstances. (See PULP-DIGESTER.) Straw is composed of a tube of woody fiber and cellular tissue, having upon its outer surface a eutiele eomposed of silicates of potassa and soda with some free silica. The woody fiber also eontains some silica. To the silicious eutiele the straw of grain or grass owes in great part its strength. Iu the boiling process, the lime and the silica eombiue, which leaves the straw in a soft and pulpy state. The mass is now ground into pulp, and then drawn into a vat, which eontains water, and kept eonstantly agitated by a series of revolving arms. A wire-gauze eylinder is so adjusted that it will revolve partially beneath the surfaee of the finid mass. The pulp adheres to the gauze, and is earried around to another eyliuder, around whieh an endless belt of felt runs. The latter eylinder presses upon the gauze, and by this means the pulp is made to adhere to the felt, and eondensed so as to give it enough eonsistency to be taken up by another cylinder, ealled the *forming* eyliuder. This is one of a pair made of poiished metal, and by them the pulp is strongly eompressed. The pulp is wound around the *former* nntil the proper thiekness is reaehed; this is determined by an indicator. Along the forming eylinder there is a groove planed ont, through which the operator now rapidly passes a wooden knife, thus severing the soft board; and at the same time he unwinds the sheet and removes it. These sheets are eut so as to form other sizes, and then dried, whieh eompletes the process. Woolen rags are sometimes ground and mixed with the straw pulp. This makes a much darker colored and heavier board, which is worth eonsiderably more than the pure straw-board. The boards, as thus manufaetured, are applicable to a great variety of useful purposes, amoug which book-binding, button-making, and paper-box manufaeture are most prominent

Until lately, the white lining of these boards was pasted on by hand, but now the white paper is put on by a machine at the rate of 20 sheets a minute. This machine is automatic in its movements; it pastes the boards, lays on the white paper from a eontinuous roll, dries, presses, and ealenders them, so that when the boards leave the machiue they are immediately ready for the box-manufaeturer.

**Straw-boil'er.** A vessel for macerating straw to form paper-stock. See Figs. 4008, 4009, and following cuts.

## Straw-braid.

Rye-straw is eommonly used for brail in this country. It should be cut when the grain is in the milk, tied np in small bundles, the heads cut off, and the straw dipped in boiling water. It is then dried in the sun, being taken in at night to avoid exposure to dew. For hats the whole straw is used. For bonnets it is split, and the part under the husk removed. The tool used for splitting straw is a piece of wood five inches long, having a series of sharp spurs near the end, and a wooden or metal spring at one side to press down the straws as they are drawn through. The straw is wetted previous to braidiug to make it pliable

A nicer method of splitting, praeticed iu Europe, is by means of a wire having four, six, or eight sharp edges, which is pushed up the hollow of the straw, dividing it into au equal uumber of parts. The varieties of braid are very nnmerous, depending on the size and kind of straw, whether split or whole, aud the patterns formed by the different methods of interweaving.

The Leghorn, or Italian straw-braid is made from a variety of wheat cultivated for this purpose. The straw is harvested in the mountainous regions of Prato, Empoli, etc., where the vegetation is poor and stunted, the soil being light and sandy.

The fields are worked and weeded by hand. 14 bushels of seed are usually sown to the acre; two bnshels being "broadcast" at each time, and eaeh sowing made at a differcnt angle to the first. The effeet of this is to produce a very close, eompaet growth, and only one elongated stem rises from each seed sown.

The straw is harvested while green, and before the ear is fully developed. It is gathered into small sheaves, weighing about half a pound eaeh, whieh are at first placed upright in the field to dry, one acre bearing about three thousand of them. Next day these bundles of straw are spread out over rocks and pebbles in the dry bed of water-courses, where they are submitted to the action of sun and dew. At night they are covered up to protect them from raiu. The straw is then bleaehed by means of sulphurie-aeid gas.

The ear is uext taken below the first joint, the lower useless portion separated, and the straw cut into lengths of four inches. Each blade of straw usually furnishes three sueh lengths. It is then bleached again.

At this point the straws are sorted according to their various sizes, — an operation performed by women who acquire, through long habit, a most remarkable taet in distinguishing the smallest variation iu diameters, as may be inferred from the fact that in front of each operator are placed goblets nnmbered from 30 to 180, each of which is the receptable for a special size of straw.

The braids are plaited with from 11 to 13 straws each. Their length is from 300 to 320 feet, their width and the quantity of straw entering into them varying aecording to quality. With No. 30 straw the braid is coarse and wide, and weighs two pounds and a half. It takes, however, a whole month to plait a single bounet from such straw. With Nos. 120 to 180 it takes about one pound and a half of straw to a braid. With extra straw (No. 180) the braids are not more than 0.039 of an inch in width, and it takes six months' labor to make a sufficiency for a single bonnet for a lady.

The braids are cleaned, exposed to the sun for a short time, and then sent to the manufacturer to be sewn into shape. This last operation is performed with the very greatest care, the stitehes being nearly invisible and yet strong, and not liable to unravel durng the pressure to whieh the hats are often subjected after being sized.

The hats are "ungreased," and any bumps or protuberances on their surfaee are effaced by rubbing one portion of the tissue against another, or by means of frietiou with a dog-skin glove.

**Straw-car'ri-er.** 1. An endless apron in a thrashing-machine to lift the straw as it comes from the cylinder, and discharge it at the tail of the machine. The carrier being of open work, the grain and chaff are sifted out on the way. See THRASHING-MACHINE.

2. A straw-elevator at the end of the thrasher to lift the straw on to the rack.

**Straw-cut'ter.** *Cutting-boxes* or machines for reducing long feed, such as straw, hay, or corn-stalks, to chaff are very numerons and varied.

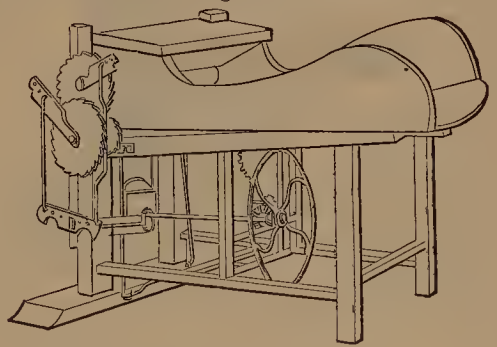
They may be classed under certain heads.

I. The gnillotine-knife, operating in a straight line upon the straw which issues at a throat. *The knife reciprocates.*

II. The radial or curved knife, attached to a wheel revolving on an axis parallel to the direction of the feed, and thus cutting off the straw as it issues from the throat of the machine. *The knife revolves in the plane of its length.*

III. The cutting roller or pair of rollers with knives, between which the straw passes. *The knives are across the throat of the machine.*

Fig. 5955.

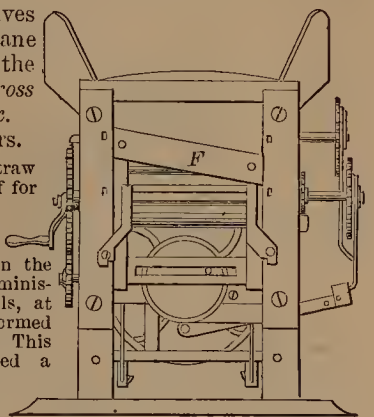


IV. Cutting knives revolving in the plane of the direction of the feed, and *cutting across the mouth of the box.*

V. Straw-grinders.

The Hebrews cut straw and grain in the sheaf for food.

Hohlfield, of Saxony, 1711-1771, iuvented a straw-ehopper, while in the serviee of the Prussian minister, Count de Podenils, at Gusow. We are not informed as to its construction. This inventor also produced a thrashing-maehine, an odometer, a pedometer, a loom for figured fabries, a harpsichord, and several other ingenious maehines.




*Guillotine-Cutter Chaff-Box.*

The chaff-cutter of the last century was a trough in whieh the straw or hay was pushed along by a fork, so as to be exposed at the end of the trough to a knife whieh was pivoted at one end, and oscillated by hand.

I. Of the guillotine knives, some make a simple straight cut, others an oblique cut, others a draw cut.

*a.* The straight cut is when the whole edge of the knife is brought into contact at once with the body of straw. This is so interior in its results that it needs not to be illustrated.

*b.* The knife is presented obliquely so as to commence at one corner of the throat and terminate at the diagonally opposite corner.

This form is seen in the early pateuts of Hotchkiss, August 2, 1808, and January 18, 1817.

Fig. 5955 may be given as a sample. The knife *F* moves in vertical guides, the *draw* of the cut being due to its oblique position relatively to its line of motion. The main shaft is placed beneath the box and operates the knife-gate by a wrist-pin. A cam on the shaft also operates the lever which actuates the ratchet feed-wheels by means of conuecting-rods.

Fig. 5957.

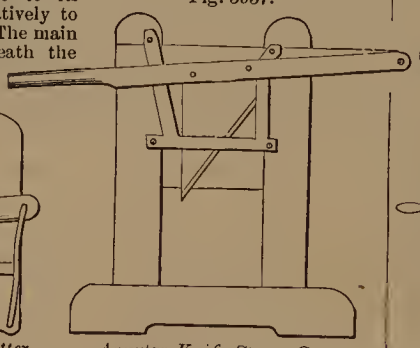
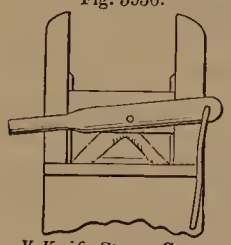


Fig. 5956.



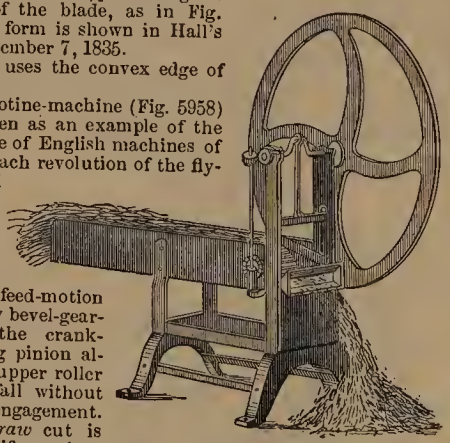
*V-Knife Straw-Cutter.*

*Angular-Knife Straw-Cutter.*

Modifications are seen in machines with V-shaped cutters, presenting the concavity of the blade, as in Fig. 5956. This form is shown in Hall's patent, November 7, 1835.

Fig. 5957 uses the convex edge of the knife.

Fig. 5958.

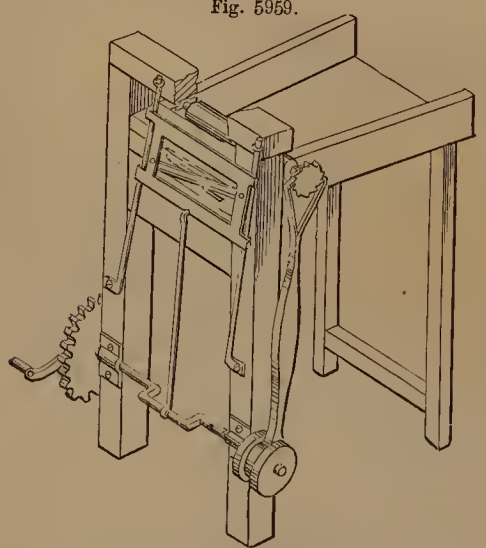


*Guillotine Chaff-Cutter.*

The guillotine-machine (Fig. 5958) may be taken as an example of the present state of English machines of its kiud. Each revolution of the fly-wheel and crank gives an effective cut to the oblique guillotine-knife. The feed-motion is derived by bevel-gearing from the crank-shaft, a long pinion allowing the upper roller to rise or fall without risking a disengagement.

*c.* The *draw* cut is when the knife receives a positive endwise motiou in addition to its descendiug motion. The latter is the most efficient.

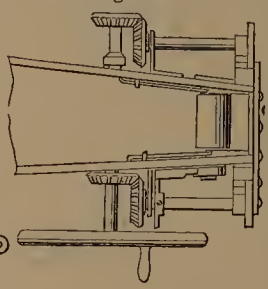
Fig. 5959.



*Draw-Cut Straw-Cutter.*

In Fig. 5959, the knife has cutting edges above and below, and is reciprocated in inclined guides, which give it a positive endwise motion.

Fig. 5960.



*Double-Edged Straw-Cutter.*

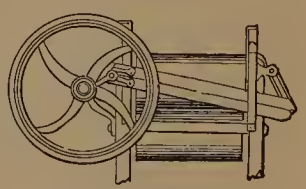
Fig. 5960 is a machine in which the knife is also double-edged. The ends of the knife are attached to separate co-acting cranks, which give a downward and lengthwise motion to the knife.

In Fig. 5961, one end of the knife is operated by a crank, while the other depends from a swinging arm.

Class II. Knife cutting in a plane at right angles to the feed.

The knife is curved, so as to act diagonally across the body of straw, moving with the edge in advance. The feed is by a worm on the axis of the cutter-wheel, acting on wheels upon the axes of the feed-rollers. The feed is continuous, the straw advancing the length of the chaff between each cut.

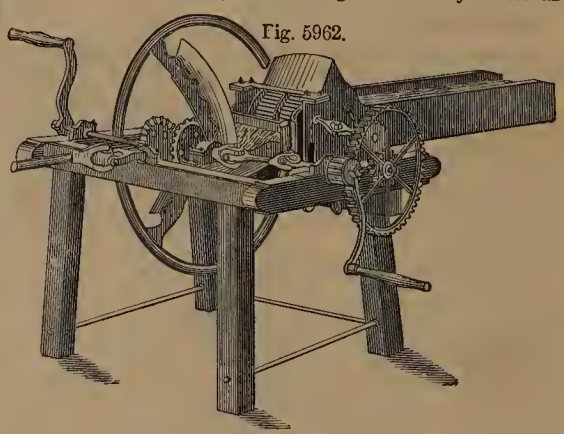
Fig. 5961.



*Straw-Cutter.*

Lester's machine, patented in England in 1800, had a knife attached to a fly-wheel, and cutting transversely across the throat. The earliest feed was an endless web of cloth passing over two rollers; but Heppenstall's improvement, patented in 1818, substituted a worm to turn two feeding-wheels to convey the straw to the knives attached to two arms of the fly-wheel.

Fig. 5962.

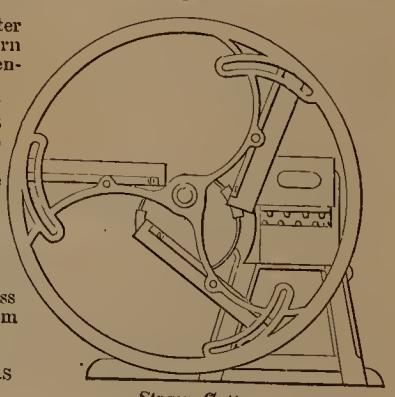


*Corne's Chaff-Cutter.*

Corne's straw-cutter (English) is a modern form of the same general design.

It has capacity for adjustment to cut chaff from ⅛ inch to 4 inches long.

Fig 5963.



*Straw Cutter.*

Fig. 5963 has three knives, which are pivoted to the wheel-arms and governed by an eccentric, so as to have a rocking motion as they pass the throat, giving them a draw cut.

Class III. has several varieties:

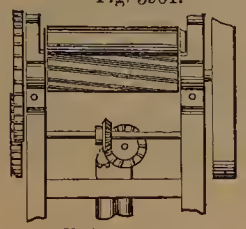
*a*. Radial knives mutually interlocking, as in the Sanford patent, October 12, 1843.

*b*. Knives cutting against a flat-faced roller, usually made of leather or raw-hide disks on a mandrel.

Fig. 5964 has spiral knives, with roller.

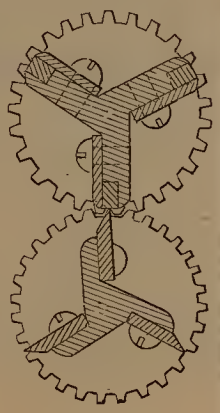
In Fig. 5965, the edges of the spiral knives cut against corresponding surfaces of comparatively soft metal which are clamped in the arms of the cylinder above.

Fig. 5964.



*Spiral-Knife Straw-Cutter.*

Fig. 5965.



*Straw-Cutter.*

*c*. In Fig. 5966, one roller has spiral knives and the other spiral abutment corrugations, whose intervals are entered by the knives.

The furze-cutter of England has interlocking spiral knives, like that just described. See Fig 946, page 392.

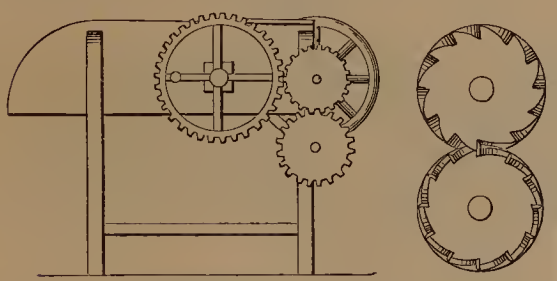
*d*. Rollers with spiral flanges mutually interlocking, as in the Macomber patent, November 5, 1850.

Fig. 5967 is an illustration of a machine in which the flanges make a shear-cut past each other.

## IV. Cutting-knives upon a cylinder on a horizontal axis in front of the throat, and cutting toward the opening.

Salmon of Woburn, England, about 70 years since, introduced the oblique knife attached, cylinder fashion, between two

Fig. 5966.



*Spiral-Knife Straw-Cutter.*

wheels and cutting toward the throat of the straw-box; revolving in the same plane of motion as the straw is moved.

The feature is also seen in United States patents, Eastman, January 29, 1822; Denson, May 2, 1835.

In Fig. 5968, the cutters extend diagonally along the cylinder, being secured at their ends to the rims of the cylinder-heads. A sheet-iron band forms the periphery of the cylinder.

In Fig. 5969, the hay, after being cut, is crushed between rollers, and winnowed to expel the dust.

## V. Feed-grinders.

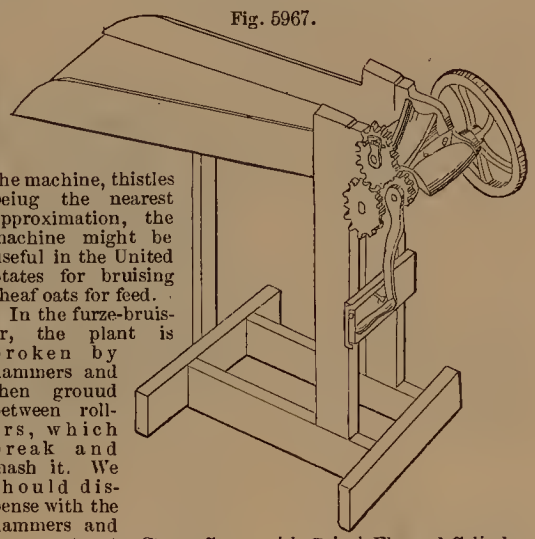
Fig. 5970 has a series of circular cutters *C* on a horizontal shaft. The knives work against an apron *J*, and the spaces between the knives are kept clear by the fingers *L*.

Fig. 5971 has a series of circular saws on two shafts. The teeth of the larger saws are designed to split or divide the stalks, and are aided by the smaller saws to crush the articles to be cut. Notched and forked plates pass between the saws, to clear them.

Supplementary to the subject of machines for cutting straw, hay, etc., into chaff for feed, may be mentioned a machine used in England for grinding the furze (*Ulex Europæus*, also called *gorse*, or *whin*). See Fig. 946. This is a thorny, evergreen, succulent plant, which covers square miles of country, making the landscape yellow with its beautiful yellow blossoms. It is cut with bill-hooks, and handled with leather mitts. It is relished by cattle when bruised so as to mash the spines with which it is so plentifully covered.

Although we have nothing like the furze to run through

Fig. 5967.



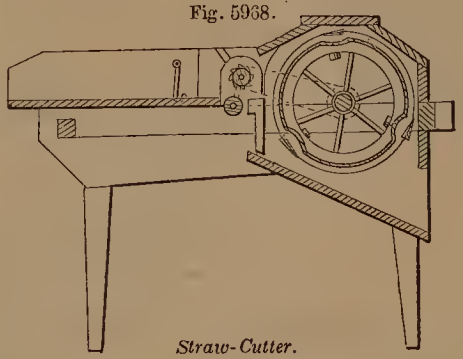
*Straw-Cutter with Spiral Flanged Cylinders.*

the machine, thistles being the nearest approximation, the machine might be useful in the United States for bruising sheaf oats for feed.

In the furze-bruiser, the plant is broken by hammers and then ground between rollers, which break and mash it. We should dispense with the hammers and be content with a mashing action which would break the kernel and scatter flour enough over the straw to make the whole mass palatable.

The peasants of Brittany use a more primitive mode of producing the same effect: a pair of pestles suspended from the

Fig. 5968.



*Straw-Cutter.*

ends of a bar, which is oscillated by the feet of a man standing thereon.

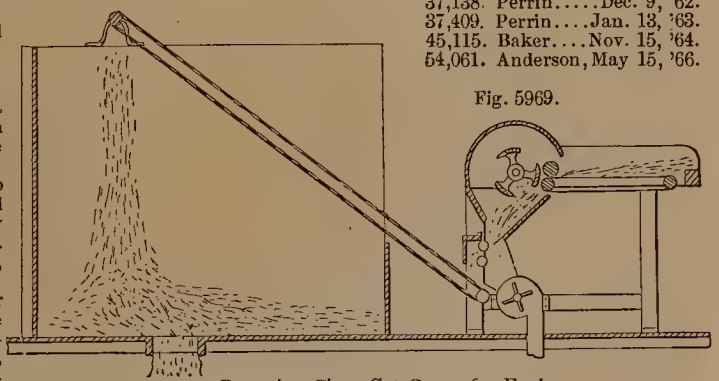
**Straw-drain.** (*Husbandry.*) A drain filled with straw.

**Straw-fabric Loom.** A loom for making goods the weft of which is of straw. Each piece of filling is laid in separately, and looms of this character are made to work with *straw*, *slats*, *splints*, *wands*, *willows*, *cane*, *rattan*, *palm-leaf*, *splints*, *whalebone*, and what not. See Slat-weaving Loom, page 2203.

See also following patents: —

37,138. Perrin.....Dec. 9, '62.
37,409. Perrin....Jan. 13, '63.
45,115. Baker....Nov. 15, '64.
54,061. Anderson, May 15, '66.

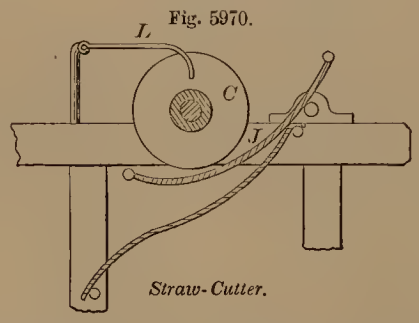
Fig. 5969.



*Preparing Short-Cut Straw for Feed.*

56,493. Free.....July 17, '66.
57,898. Hasecoster, Sep. 11, '66.
65,266. Perrin....May 28, '67.
68,695. Brown....Sep. 10, '67.
69,309. Brown.....Oct. 1, '67.
70,072. Brown....Oct. 29, '67.
70,318. Brown....Oct. 29, '67.
70,945. Angell....Dec. 10, '67.

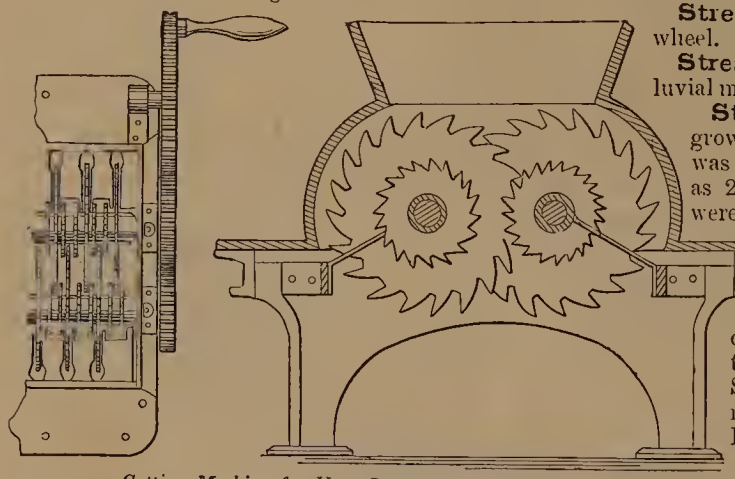
Fig. 5970.




*Straw-Cutter.*

71,852. Chandler, Dec. 10, '67.
75,500. Walkins, Mar. 10, '68.
79,923. Smith...July 14, '68.
100,477. Fitts....Aug. 16, '70.
111,343. Hastings, June 31, '71.
127,318. Devol....May 28, '72.
133,332. Murphy, Nov. 26, '72.
135,427. Hastings, Feb. 4. '73.
153,417. Baldwin, July 28, '74.

Fig. 5971.



*Cutting-Machine for Hay, Straw, and Vegetables.*

**Straw-hat Mak'ing.** Tuscan straw is prepared by pulling the wheat while the ear is in a milky state. The wheat is sown very close, so that the straw is thin and short. The straw is spread out upon the ground for three or four days in fine hot weather to dry. It is then tied up in bundles and stacked, to complete the drying. After remaining in the mow for about a month, it is removed to a meadow and spread out, that the dew, sun, and air may bleach it. During this process it is frequently turned. The first bleaching being complete, the root and lower joint are pulled off, the straw is then steamed, and afterward fumigated with sulphur to complete the process. See STRAW-BRAID.

**Straw-pa'per.**

Straw is cut into small pieces by a chaff-cutting machine or grinder (see Fig. 4015), and then subjected to the action of a boiling solution of hydrate of soda or potash. It is then put into a vessel with a perforated false bottom, and a pipe communicates from this to a close iron vessel containing alkaline solution, which is kept boiling by steam heat. (See PULP-DIGESTER, pages 1821 - 1823.) The pressure of steam in this vessel drives the alkaline solution through the pipe, and it falls in streams upon the cut straw. From 30 to 40 gallons of the solution are used to each 100 pounds of straw. The liquor is caused to circulate through the straw for 8 or 10 hours, when the liquor is drawn off, and water is run through the straw until it runs off clear. The straw is then put into a bath of hypochlorite of alumina, in order that it may be bleached and its fibers disaggregated. There it remains 12 or 13 hours, being stirred from time to time. The straw is by this time reduced to *half-stuff* of good color, when the liquor is strained off, and the pulp well washed with boiling water. It is then carried to the beating-engine, and made into paper. It is customary to use a portion of rag pulp where a good quality of paper is desired. See Figs. 4008 - 4112, and pages 1821 - 1823.

**Stray-line.** (*Nautical.*) A portion of the log-line, say 10 fathoms, between the log-chip and the first knot, and left unmarked in order to allow the latter to get out of the eddy in the ship's wake before turning the glass. When the *stray-mark* is reached, the glass is turned, and counting commences. See LOG.

**Streak.** 1. (*Shipwrighting.*) A course of planking on a vessel's side. See STRAKE.

2. The color of a mineral, when scratched to detect the appearance of ore.

**Stream-an'chor.** (*Nautical.*) An anchor of a grade between the *bower*, or large anchor, and the *kedge*. Used in warping; or mooring in a place but slightly exposed.

**Stream-ca'ble.** (*Nautical.*) One smaller than the cable of the *bowers*, and used in mooring or riding by the stream-anchor.

**Stream'er.** A pennon. See FLAG.

**Stream-tin.** (*Mining.*) Tin ore found in lumps in diluvial formations.

**Stream-wheel.** An *undershot* or *current* wheel.

**Stream-work.** (*Mining.*) Work on alluvial metalliferous deposits; of tin, for instance.

**Street-car.** The street-railway was a growth from the *tram-road* system which was in use in the English collieries as much as 275 years ago. The *tramways* at first were flat boards, balks, or paving-stones, so as to allow the wheels of the *trams* (wagons) to roll more easily, and prevent the road wearing into chuck-holes. This is a very ancient device, as old as the moving of the obelisks and ashlars of Egypt and Syria upon rollers running on a temporary track of timbers. See TRAMWAY; RAILWAY.

To this succeeded *rails* of wood, which are described, in a publication of 1676, as being shaped so that the "four rollers" of the wagon "fitted" to them. They were laid on transverse sleepers and secured by wooden pegs. It may be said with truth that these tram-roads were the precursors of our street-railways, as they united the cities with the suburbs.

Wooden rails with malleable iron caps were used in 1716.
Cast-iron rails in 1767.
L-shaped rails in 1776.
Rolled rails in 1820. See RAIL, pages 1857, 1858.

The railways originated in the collieries of the North of England, and the iron district of Shropshire.

They were at first used entirely for freight. When rails were invented it was a century and a half before steam-cars were made to run upon them. On the early railways of England horses were employed for 150 years. The Milton and Quincy, Mass, Railway, 1826; the Baltimore and Ohio, 1830; the Mohawk and Hudson, N. Y., 1830, were all worked by horses at the first. See RAILWAY, page 1861. The steam-car was at first made for common roads, as the steamboat was first made for canals. The early steam-carriages were those of

Cugnot (French).....1769
Hornblower (English)....1769
Symington (Scotch).....1770
Murdoch (English).....1784
Evans (American).....1787
Medhurst (English).....1800
Bompas (English).....1828

See STEAM-CARRIAGE.

The *locomotive*, considering the term as referring to a *steam-car on rails*, originated in Wales. The list of early inventors is about as follows: —

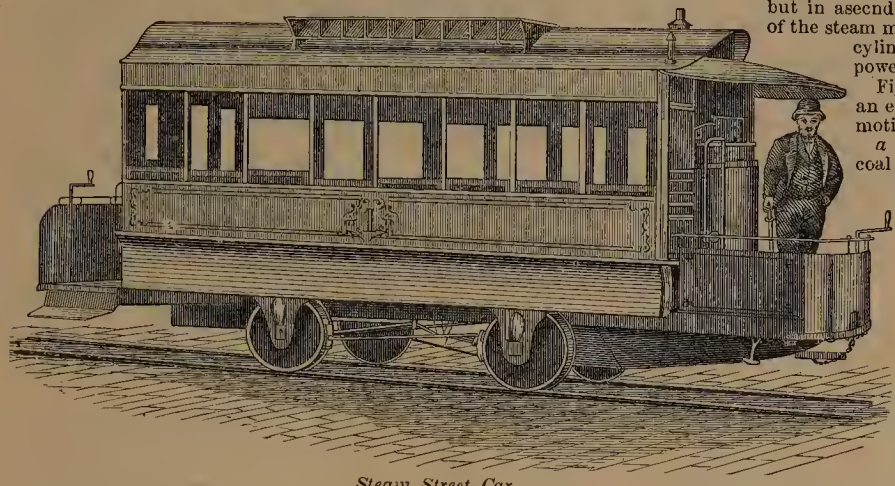
Trevethick (Wales).....1802
Blenkinsop (England)....1811
Blackett (England).....1812
Hedley (England)..... 1813
Stephenson (England)....1815
Stephenson (England)....1825
Stephenson (England)....1829
Hackworth (England)....1829
Braithewaite and Ericsson (England).....1829

The three latter were contestants at the great trial on the Liverpool and Manchester Railway, in 1829. See LOCOMOTIVE, pages 1343 - 1347.

For other forms of steam-moved vehicles, see ROAD-ROLLER; STEAM-PLOW; PORTABLE ENGINE; TRACTION-ENGINE.

Beginning with horses, and then using stationary engines to raise or lower the wagons on grades, and to the *staiths* whence

Fig. 5972.

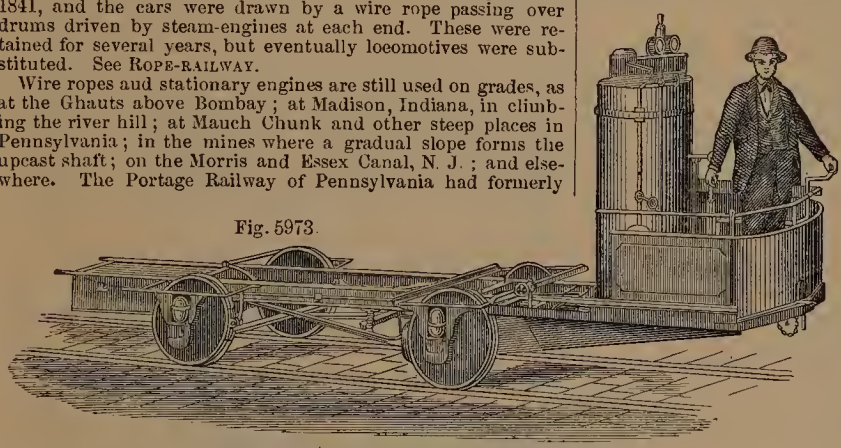


*Steam Street-Car.*

they discharged by chutes into the colliers; the contest for some years previous to 1829 had been between stationary and locomotive engines. Stephenson threw the weight of his influence in favor of the latter, and the trial on the Liverpool and Manchester Railway was to encourage invention on the latter plan. The London and Blackwall Railway of 6½ miles was opened in 1841, and the cars were drawn by a wire rope passing over drums driven by steam-engines at each end. These were retained for several years, but eventually locomotives were substituted. See ROPE-RAILWAY.

Wire ropes and stationary engines are still used on grades, as at the Ghauts above Bombay; at Madison, Indiana, in climbing the river hill; at Mauch Chunk and other steep places in Pennsylvania; in the mines where a gradual slope forms the upcast shaft; on the Morris and Essex Canal, N. J.; and elsewhere. The Portage Railway of Pennsylvania had formerly

Fig. 5973.



*Truck and Machinery of the Baxter Steam-Car.*

ten inclined planes overcoming an elevation of about 1,400 feet, going west. The western terminus of the railway is about 1,173 feet below the summit level. See INCLINED PLANE, pages 1174–1177.

Rope railways are also used in overcoming special elevations, such as the passenger elevators at Niagara, Cincinnati, and Pittsburgh; a vertical elevator for cars is used at Hoboken, N. J.

Street-railways for passenger cars were first established in the United States about 1850, and in England about ten years afterward. The Boston and Cambridge Railway, commenced in the fall of 1858, was the first in New England.

Street-cars are usually drawn by horses, but many attempts have been made to drive them by machinery. Steam-engines, known as *dummy* engines, have been used with success, but the fire and the noise of escaping steam are considered objectionable.

Fig. 5972 is a view of the Baxter steam car; Fig 5973, the truck and machinery of the same.

The boiler is upright, and is placed on the front platform; a non-conducting partition prevents heat from entering the car.

The engine is below the platform. It is compound and double-acting. In ordinary use, the steam from the smaller cylinder exhausts into the larger; but in ascending grades, the full pressure of the steam may be made available in both cylinders, greatly increasing the power.

Fig. 5974 is the Knapp car; *B* an elevation, and *C* a plan of the motive apparatus.

*a* is the furnace, supplied with coal from the platform through the chute *b*; *c*, the boiler; *d d*, the cylinders. The exhaust steam is condensed by a blast of cold air from the fan-blower *f*; *g* is a smoke-pipe, terminating in a reservoir *h* containing milk of lime, to remove the carbonic acid from the smoke; this also acts as a spark and dust arrester, so that the gas, which finally issues from the pipe *i*, is invisible, and causes no inconvenience to the passengers or others.

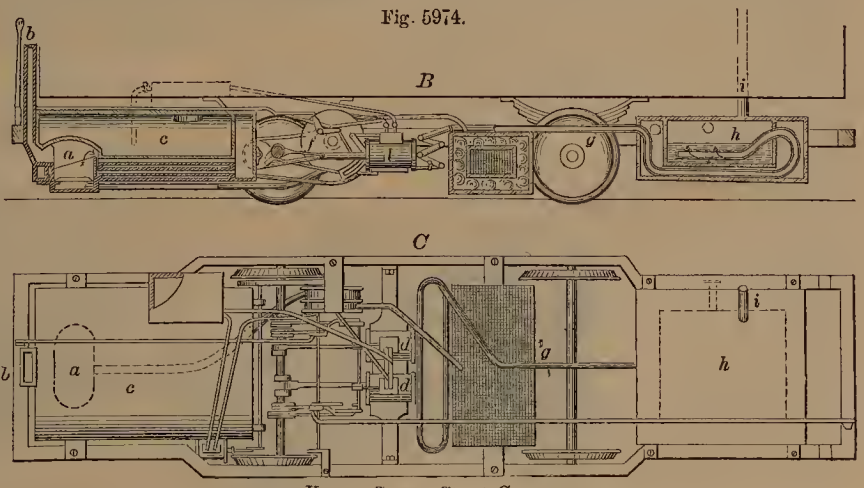
The car, Fig. 5975, has a circular cab *B*, which contains the dummy engine and boiler, and is supported on a circular platform *I* resting upon the fore truck *V*, and is provided with anti-friction rollers *h i*, upon which the front of the car body *A* rests; the shell of the cab also bears against vertical anti-friction rollers *m m*. A reach and center pin *U* connect the body and fore truck of the car, and the body is supported on a similar pivoted truck, provided with anti-friction rollers, enabling the two parts to turn independently of each other. The front and rear axles of the fore truck are coupled by connecting-rods *N*, and the rear axle *J*, which is cranked, is worked as a driver by a pair of oscillating engines. See also STEAM-CAR.

The following statement includes a number of applications of condensed air to the driving of street-cars: —

A British form of steam-locomotive, in which the engine carries no boiler, but a supply of steam sufficient for a trip, is termed the Fireless Locomotive.

Todd's combined dummy and car has a main lower frame 22 feet 6 inches long over the buffers, 7 feet wide over all, and 3 feet high from the rail to the top; and on this frame is placed the 14-feet body of an ordinary car. In the center of the frame are two receivers, each containing 30 cubic feet of water. Below the buffer-beams are screw-couplings and stop-valves with perforated pipes running right through the receivers. The wheels are 24 inches diameter, placed 4 feet 6 inches between centers. Cylinders, 9 inches diameter and 8 inches stroke, surrounded with large jackets open to the water of the receivers. At each end of the car, outside the dash-plate, is placed a brake-handle, and on either side of this a regulator and reversing handle, all arranged as shown. These latter handles fit into spring sockets,

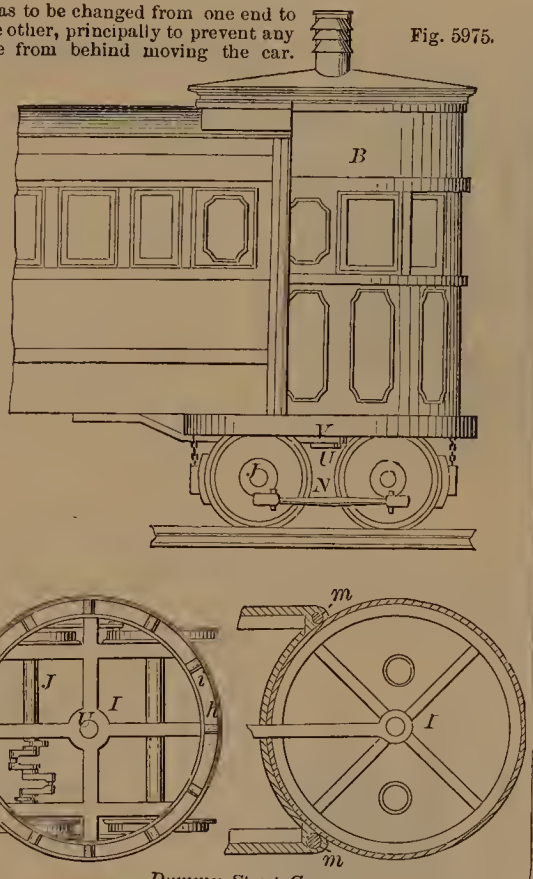
Fig. 5974.




*Knapp Steam Street-Car.*

so as to be changed from one end to the other, principally to prevent any one from behind moving the car.

Fig. 5975.







*Dummy Street-Car.*

There are four sand-boxes, with handles brought to the foot-boards. There are two exhaust-pipes, the end of each projecting slightly upward from the edges of the curtains over the foot-boards; and by a cock the waste steam is turned into whichever pipe happens for the time to be at the rear end of the car. All the working motion is quite protected from dirt by light boxes which have hinged doors at the sides. The engine is started on its journey with an initial pressure of 200 lbs. to the inch; and owing to the jacketing of the cylinders, the loss by radiation is said not to exceed 5 lbs. pressure per hour, allowing the engine to run 40 miles on level lines at one charging of the boiler.

The upper figure is a longitudinal section of the car, and the lower is an exterior elevation, also showing the stationary boiler from which the apparatus is charged.

Medhurst, English patent, August 2, 1800, proposed to propel carriages by means of compressed air carried in a reservoir, using a single-cylinder engine, or a double-cylinder engine with compound beam, according to the amount of power required.

Bompas, April 29, 1828, patented a method of propelling carriages or boats by means of air compressed by pumps in cylindrical iron vessels, with hemispherical ends placed in one or more rows underneath and behind the carriage. Fixed reservoirs to be located at appropriate stations, to replenish the air as the pressure becomes diminished in the cylinders; the compression to be from 30 to 150 pounds or upward. He preferred to use two cylinders, working expansively, if desired. The use of air or gas, condensed by being disengaged chemically from substances with which it is in combination in a confined space, is also mentioned.

Wright, April, 1828. Compressed air, contained in metallic cylinders beneath the car and charged from a stationary reservoir or by means of air-pumps, was admitted by appropriate pipes with valves to a third cylinder, where, by means of a furnace beneath, it was heated, and its expansive force increased before entering the working cylinders; or steam generated by the furnace might be mingled with the compressed air when it entered this third cylinder. He also proposed to use an eccentric on the driving-shaft to work a pump for compressing air into either of the cylinders when the carriage was going down hill, and to serve as a brake in descending.

Mann, June 1, 1829. Application of air condensed by steam-engines, wind or water mills, or other mechanical power, as a motor for vessels or carriages. The air to be condensed in portable reservoirs, to be carried on the carriages, condensed by steam-engines at the different stations along the route, or preferably conveyed along the line by pipes. Various other applications are pointed out.

Surrey, September 1, 1856. Compressed air, to be carried in portable vessels or supplied to the carriage at suitable points on the route by a tube from the main reservoir at the principal depot. In the former case, several small vessels preferred to one large one, as the air from those which have become partially depleted may be employed in descending grades, or where less power is required, and the full vessels reserved for use on up grades or for high speeds.

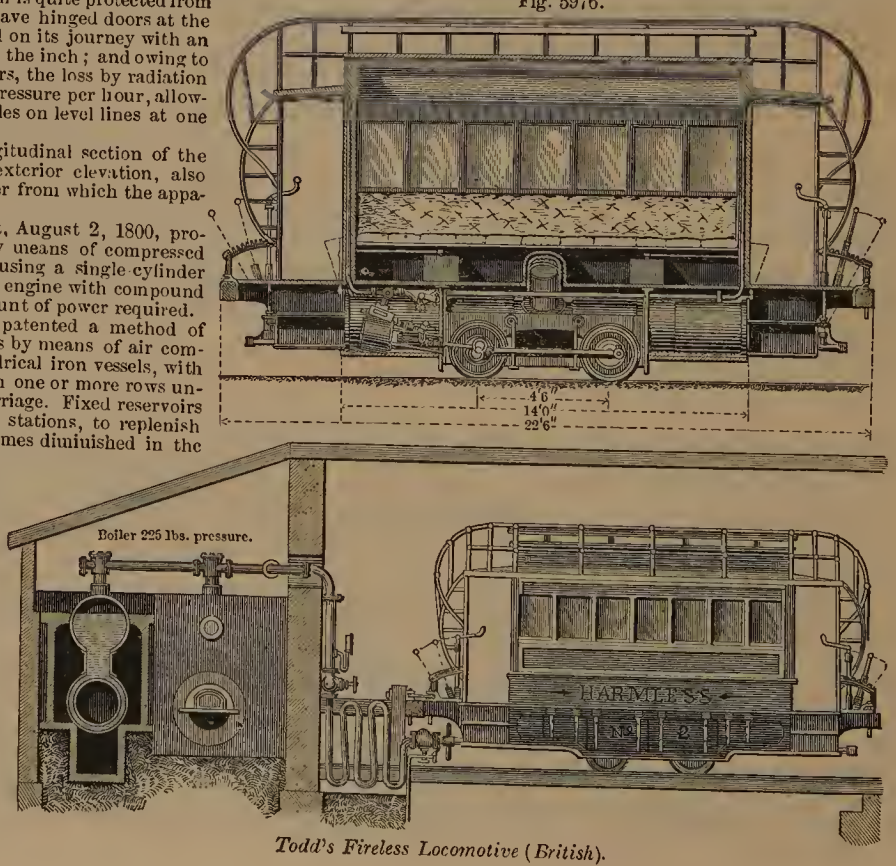
Pinkus, March 1, 1834. A pneumatic tube is laid below the railway, and has section valves at suitable intervals, dividing the tube into compartments, which are separately exhausted by engines at each of these stations.

The piston is attached to a frame or carriage traveling on two wheels, one in front, and the other behind, and having circumferential grooves fitting a continuous rib on the interior of the tubing. An arm projecting upwardly from the piston-carriage passes through a slit in the upper part of the tube, and is connected to the car, or the first of a series of cars on the railway. The slit is closed by a flexible valve arrangement, kept closed in front of the "dynamic traveler" by atmospheric pressure, but pushed aside as this advances, to admit air behind the piston. The section valves are opened to permit the passage of the traveler, and each may be closed after it has passed, enabling the work of exhaustion in the preceding section to be recommenced. See ATMOSPHERIC RAILWAY, pages 179–181.

Pinkus, August 26, 1839. Propelling boats or cars by gas-explosive engines. The engine has double-acting gas and air pumps, two piston-cylinders connected with two globular explosive chambers having igniting slides and safety-valves. Arrangements may be made for enabling the engine to take gas from the main without stopping. In this case the engine is provided with a flat pipe or tongue suspended by a ball and socket joint, and made so as to form an air-tight joint with the main or valve. The tongue is also furnished with a valve which shuts when it leaves the main or valve.

Count de Fontainemoreau, June 21, 1844. Locomotive-engines, either reciprocating or rotary, are put in motion by either

Fig. 5976.




*Todd's Fireless Locomotive (British).*

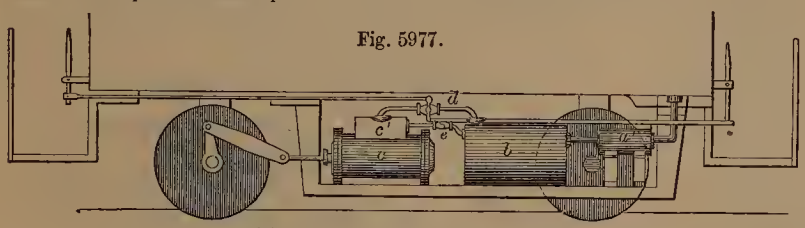
compressed or rarefied air derived from a tube along the roadway. Above the tube are fixed distributing-boxes, having a valve at bottom, and other valves at top, which are opened by a slide carried along with the locomotive aud running in a groove at the top of the box, having a strip of sheet-iron on one side, and a leathern strip on the other; the valves automatically close after the slide passes over them.

Parsey, October 17, 1844. Employs a receiver and a regulating-chamber, where the density of the air is reduced, and from which it passes to the valve-box of the cylinder. After doing its work, it may be allowed to escape, or it may bc forced back into the rceeiver by two air-punips contained within it and communicating with the two ends of the working cyliuder See pages 603, 604, Vol 1.

Anderson, June 29, 1846. Using gun-cotton or yarn as means of propulsion. The locomotive has two cylinders, enlarged at thcir outer extremities, having pistons connected together by side-rods, and each furnished with a valve to allow escape of gas during the down stroke. The cottou or yaru is fed by rollers alternately in the narrow extremity of each cylinder through a small slit, and is exploded by wires from a galvanic battery.

Fell, October 7, 1847. Employs rarefied or compressed air. The latter is conveyed by a main or pipe placed centrally between the rails to reservoirs at equal distances along the line. These are located below the maiu, and have valved pipes passing through it, and flush with its npper surface. The main is partially embraced by a long slidcr attached to the engine, connected by a pipe with its air-chamber, and as the engine passes over each reservoir, levers connected with the valves of the pipes leading therefrom are struck by a bar attached to the eugine opening the valves, and air passes from the reservoirs through the slider and tube into the air-chamber of the engine, whence valves prevent its escape.

Fig. 5977.



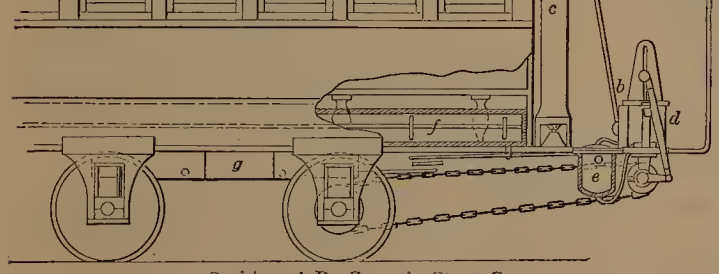
*Smith's Pneumatic Engine for Street-Cars.*

A different arrangement of valve is employed if rarefied air is used.

Vau Rathen, November 2, 1847. High-pressure air from a reservoir is made to enter a set of expanding and warming tubes, by which its pressure is redneed from about 50 to 5 atmospheres, while retaining its heat aud elasticity, and thence a moderator or chamber provided with a piston which is forced into the chamber by the action of a regulating spring or weight, and raised hy the pressure of the air. From the moderator the air passes to the propelling machinery.

Johnson, June 26, 1856. Proposed to carry a small steam-engine and hoiler for working two or more double-action air-pumps to compress the air into a receiver, whence it was to be dclivered to the main actuating cylinders of the engine.

Fig. 5978.



*Smith and De Coppet's Street-Car.*

Barsanti and Matteucci, June 12, 1857. Apparatus for obtaining motivc power by the explosion of hydrogen or other inflammable gas mixed with atmospheric air. In one method the vacuum produced beneath the piston by the explosion is alone availed of, two alternately acting cylinders being employed. In a second plan both the force of the explosion and the vacuum are utilized. Four cylinders are employed, one on each of two pairs of driving-wheels. The locomotive carries a reservoir of gas with regulating apparatus to give a uniform supply. The charge is exploded by a cylindrical circuit-breaker rubbing against a steel spring and rotated by band and pulley counection with the fly-wheel shaft.

Crever and Keeney, September, 1859, proposed the use of a stationary steam-engine at one of thc termini, for compressing air into a large air-holder A main connected with this reservoir leads along the track, and is provided at intervals with ascending branches having valves, which may be opened by contrivances under the control of the conductor, in order to replenish a compressed air-tank carried beneath the car.

Liquid carbonic-acid gas exerts a pressure of about 690 pounds per square inch at 42° Fah., 855 pounds at 60° Fah.. and 1,200 pounds at 86° Fah. Onc pound of the liqnid expands so as to form rather more than eight cnbic feet of gas. It may be kept in tanks made of several thicknesses of sheet-steel rolled together in the form of a scroll and united by a solder of pure tin run in between the layers. (Mathews's patent.) Tanks made of a single thickness $\frac{1}{16}$ inch of sheet-steel, lapped four inches at the edge, and soldered in this way, may be trnsted to sustain a pressure of 300 pounds to the inch, the bursting pressure being 700 lbs. One of the thicker kind above mentioned, tested by hydraulic pressure at the Newport torpedo-station, withstood strains up to 3,132 lbs. per square inch before rupture.

Barbour, March 14, 1865. Tbe car carries a supply of liquid carbonic-acid stored in a tank beneath. This is admitted in regulated quantities to the cylinder, where it expands, and after doing its work, the gas is exhausted into a reservoir over the car, having a capacity 450 times that of the tank in which it is contained in thc liquid state. It is recondensed by appropriate machinery at the stations, and again used.

Smith, Angnst 8, 1871. Compressed air, contained in a large tank on the body of the car, is admitted to a governor or regulator $a'$, and thence passes to a small auxiliary tank $b$ underneath; this is connected with the cylinder valve-chest $c'$ by two pipes, one of which $d$ is open and the other $e$ closed whilc the car is in motion, but on stopping the car the latter is opened and the former closed, causing the compressed air in the cylinder $c$ to be pumped back into the auxiliary tank, where it is stored up to assist in starting again. The illustration (Fig. 5977) shows the car-bed and lower works.

Smith and De Coppet, July 29, 1873 (Fig. 5978). Liquid ammonia, stored in a reservoir $a$, is withdrawn and injected by a pump $b$ into a vaporizer $c$, heated by a lamp beneath. The gas is conducted to the engine $d$ by a pipe, and is exhausted into a condenser $e$, where it is liquefied by a shower of spray falling through a perforated plate, the water being supplied by tanks $f$, one at each side of the car, and withdrawn therefrom by a pump. A third pump removes the ammonia from the condenser and forces it into a tank $g$ beneath the car, where it is retained for fartber use. Chains communicate motion from pulleys on the engine crank-shaft to pulleys on the driving-wheel shaft.

Bowen, September 2, 1873 (Fig. 5979). The car has under thc seats tanks for compressed air, divided into compartments by partitions. The compartments communicate with each other by valves, which allow the air to pass from one to the other when they are charged at the end of the route, but prevent its passing in the opposite direction when the compartment first drawn on has a less pressure than that which remains intact. Each compartment has a separate pipe communicating with the working-tank $d$, and valves controlling these are successively opened as the pressure becomes reduced in the compartments first drawn upon.

Turnbull (Fig. 5980) employs a cut-off which automatically varies the bulk of air admitted to the working-cylinder in proportion to the degree of compression. $e$ $e$ are air-holders; $f$, cylinder; $l$, slide-valve, working in chest $p$ and operated from eccentric $m$ by lever $n$ and rod $o$ secured to pivoted sleeve $b$, rendering the length of stroke adjustable; $q$ is an air-chest, from which the chest $p$ is supplied. The compressed air issues from the air-holders, which are connected by a pipe, throngh a valved pipe communicating with the dome $t$, and presses against the diaphragm $f$, having a stem $u$ connected with the helical spring $g$ and pivoted to the lever $v$. When, as at starting, the air in the tanks is highly compressed, the diaphragm $f$ depresses the stem $u$ in opposition to the spring $g$ and tbe lever $v$, through the medium of $k$ $l'$ $m$, causes the valve $d$ in chest $q$ to cut off at short stroke; but as the pressure becomes reduced, the spring $g$, overcoming the resist-

ance of the diaphragm, raises the stem $u$, and allows the valve $d$ to have a longer range, so as to admit a greater volume of air to the chest $p$. When the pressure in the tanks has become reduced to a certain amount, the valve $d$ ceases to operate. $z$ is a pipe conveying air from drum $t$ to the chest $q$; $i$, connecting-rod, and $k$, crank to driving-axle $c$.

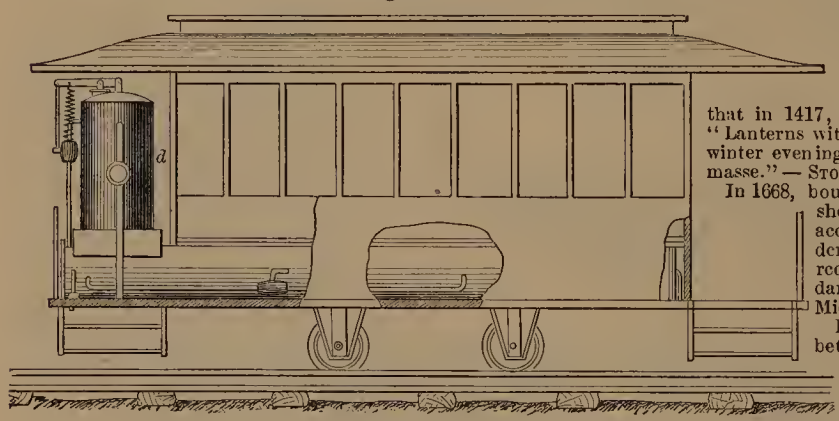
The Scott-Moncreiff system is used in Scotland.

A United States patent has been granted for a method of using the elastic force of rubber as a motor for street-cars and for other purposes. Two rubber bands, 2½ inches in diameter and 56 feet long, are stretched to 10 times that length upon two drums, on which they are coiled. The unwinding of each coil is calculated to propel the car a distance of over two miles. When the first has been unwound, the second is brought into requisition, and while it is propelling the car, the first is to be again wound up by the devices used for stopping and controlling the car.

Still another mode of operating street-cars is by means of steel springs. This form is the subject of a French patent by M. Leveaux.

The winding-up of the spring barrels, which are carried under the car, is effected by engine power, placed at suitable intervals along the track, as may be convenient for the run. The stationary engine drives by belt the horizontal shaft, carried in bearings, inclosed in a metallic tube or casing, beneath the roadway, and extending across the track; close alongside which is a covered box, sunk in the roadway and inclosing a wheel, so shaped as to connect with the winding axle of the tramway car,

Fig. 5979.

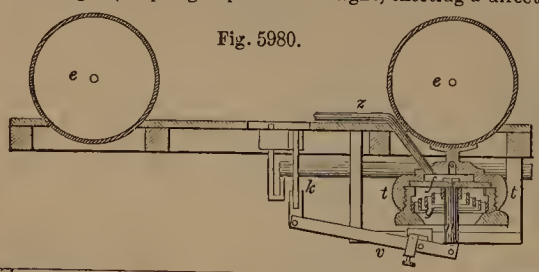


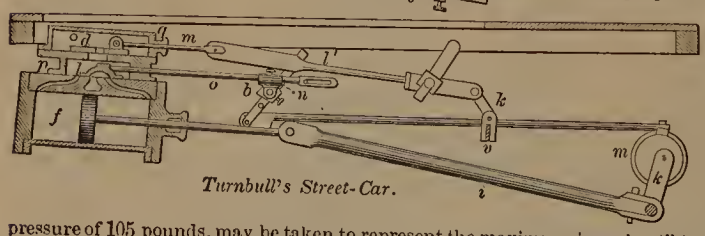

*Bowen's Street-Car.*

and thus give the requisite motion thereto. On the arrival of a car at any station, the spring barrels are wound up by the engine.

It has been computed that the actual tractive force, requisite to overcome the resistance of a street-car weighing gross 5 tons, is 60 pounds on the driving-wheels, corresponding to 720 pounds on the periphery of the spring barrel; 24 pounds and 288 pounds respectively correspond to a gross weight of 2 tons; and in like proportions for intermediate weights. So far as previous experience goes, a spring 6 pounds in weight, exerting a direct

Fig. 5980.




*Turnbull's Street-Car.*

pressure of 105 pounds, may be taken to represent the maximum in size and power of such steel springs. Steel manufacturers are now turning out springs 50 to 60 feet long, capable, when duly coiled, of exerting a pressure of 800 pounds to 900 pounds, without permanent set.

In a modification, in place of one spring, wound up at intervals along the road by means of stationary engines, a number of springs, each properly wound up, are taken on at the beginning of the route, and as fast as one expends its energy in moving the car, another is brought into play, and the trip is continued till all are exhausted, or the run is made.

**Street-lamp.** One publicly exposed on the street. The lighting of streets on occasions of rejoicings, processions, grand entries, and receptions has always been an accepted Oriental device for gracing such occasions. The feast of the dedication was such among the Jews. The Roman forum was lighted when night-games were celebrated. Caligula once lighted the whole city. Constantine lighted up the city of the Bosphorus on Easter eve.

The streets of Antioch and Edessa were lighted in the fourth and fifth centuries. The lights were lamps suspended by ropes.

The really comfortable lighting of some Eastern cities mentioned by Jerome, Libanius, Basilius, and others during the fourth century was far ahead of any attempts in that line in Greece or Rome, where people, venturing out after dark, were attended by lantern or torch bearers.

The public lighting of streets became large and regular service among the Saracens. In Cordova (Ar. *Korttubah*), under the Arabs, a person might walk after sunset for a distance of 10 miles in a straight line by the light of the public lamps and upon well-paved streets. *Al Makkari's* "History of the Mohammedan Dynasties in Spain." This was 500 years before any public lamp service in London or Paris.

The priority of lighting streets is contested between London and Paris. In London it appears that in 1417, Sir Henry Barton, Mayor, ordered "Lanterns with lights to be hanged out on the winter evenings, between Hallowtide and Candlemasse." — STOWE.

In 1668, householders were reminded that they should hang out lanterns duly at the accustomed time, and in 1690 this order was renewed, and these lights were required to be kept burning from dark till midnight every night between Michaelmas and Lady Day.

In 1716, farther ordinances for the better lighting of the city were made by the city authorities, but the duty still rested upon the people, and its execution was not a municipal act. The Common Council ordered that "all householders whose houses front any street, lane, or public passage shall, in every dark night, that is, every night between the second night after every full moon till the 7th night every new moon, set or hang out one or more lights, with sufficient cotton wicks, that shall continue to burn from 6 o'clock at night till 11 o'clock of the same night, under the penalty of one shilling." The rest of the night might take care of itself, and even these regulations were evaded and disregarded.

The streets were subsequently lighted by contract for 117 nights in the year. This proving unsatisfactory, an act of Parliament was passed in 1736, which authorized the corporation to establish glass lamps to be lighted from sunset to sunrise all the year round, and the number was increased to 5,000 within the bounds of the city proper; probably 15,000 within the group of municipalities known as London. In 1744, the lighting of the city was still farther regulated by act of Parliament, and at a somewhat later period Oxford Street alone was said to contain more lamps than all Paris.

Misson, the celebrated traveler, who visited England about 1680, states that in the streets of London, "instead of lanterns, they set up lamps which, by means of a very thick convex glass, throw out great rays of light which illuminate the path for people that go on foot tolerably well." These lamps were at every tenth house. They fell into disuse, and lanterns were substituted. These *bull's-eyes* were again introduced in London in 1799.

"Master Kemming" is noted as the enterprising establisher of public lamps in London. His oil lamps eventually gave way to Murdock's gas-lamps, 1798; and Winsor, 1803.

An order was issued in Paris, in the year 1524, that the inhabitants should keep lights burning, after nine in the evening, before the windows of all houses which fronted the streets; and in October, 1558, large vases filled with pitch, resin, and other combustibles were placed at the corners of the streets, or nearer together if necessary. These, in the next month of the same year, were superseded by lanterns.

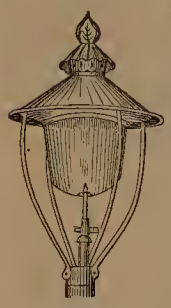
The lighting arrangements of the streets, however, still continued for many years on a very imperfect footing, and travelers still found it advisable to employ men bearing links or lanterns, when going abroad after nightfall.

In 1667 the lighting and police arrangements of Paris were improved; the project was that of the Abbé Laudati, and was legalized in 1662. In 1671 the lamps were ordered to be lighted from the 20th of October to the end of March, having previously been kept lighted only during the four winter months; at this time the lamps were kept burning on moonlight nights as well as others. Their number in 1771 was estimated at 6,232.

Amsterdam had street lanterns in 1669; The Hague, 1678; Copenhagen, 1681; Hamburg, 1675; Berlin, 1682; Vienna, 1704; Birmingham, England, 1733.

For lighting by gas, see GAS.

Fig. 5931.

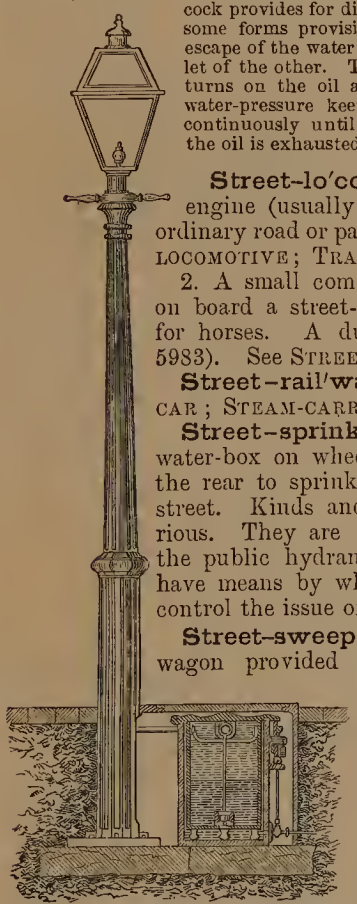


*Street-Lamp.*

In the example, the glass is in a single piece, flaring at top, and having an opening at the bottom to receive the burner. The cover, to which it is attached, is conical in shape, is supported by four rods affixed to the top of the lamp-post, and is capped by a perforated hood.

James L. Ewin's street-lamp has a supply of naphtha or other oil sufficient to last for a week or longer, contained within a reservoir located in or beneath the pavement. Water under pressure from the street-main or a service-pipe is applied to the oil by a pipe, and the oil is conducted to the burner by another pipe, the flow being regulated by stop-cocks at the burner and in the water-pipe. The reservoir is furnished with a removable bucket inclosed by a hinged oil-tight lid, as means for discharging the water and refilling the reservoir with oil. A single padlock secures the lid and the water-supply cock. In this general form the oil-supply apparatus is used in connection with an ordinary gas-lamp post. In another form, an enlargement in the post constitutes the reservoir, and a simple cock provides for discharging the water. In some forms provision is made against the escape of the water or oil through the outlet of the other. The lamp-lighter simply turns on the oil at the burner, and the water-pressure keeps the flame supplied continuously until the flow is stopped or the oil is exhausted.

Fig. 5932.



*Ewin's Street-Lamp for Coal-Oil.*

**Street-lo'co-mo'tive.** 1. An engine (usually steam) for use on ordinary road or pavement. See ROAD-LOCOMOTIVE; TRACTION-ENGINE.

2. A small compact engine for use on board a street-car, as a substitute for horses. A dummy-engine (Fig. 5933). See STREET-CAR.

**Street-rail'way.** See STREET-CAR; STEAM-CARRIAGE.

**Street-sprink'ler.** A cask or water-box on wheels, with a rose at the rear to sprinkle water upon the street. Kinds and capacities are various. They are usually filled from the public hydrant or fire-plug, and have means by which the driver can control the issue of water.

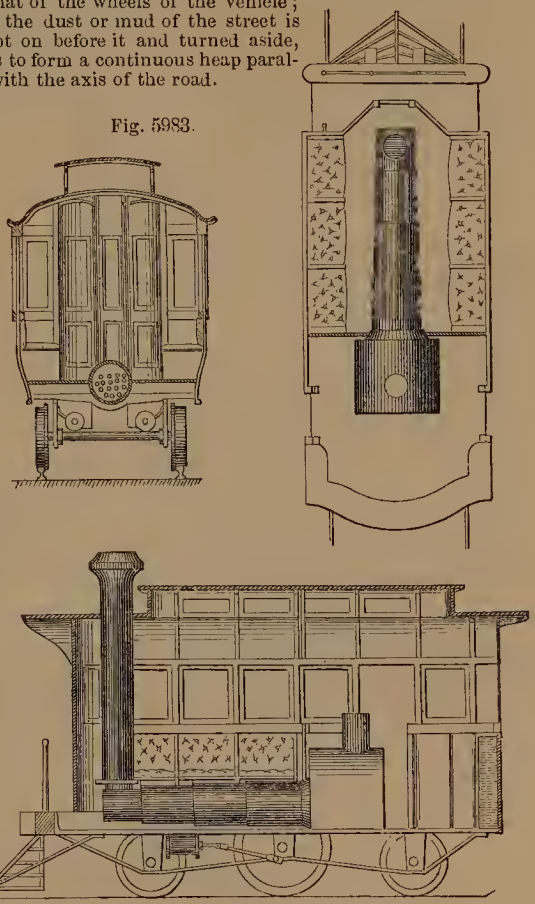
**Street-sweep'ing Ma-chine'.** A wagon provided with scrapers and brushes for gathering up street-dust and mud and depositing it in the wagon-bed.

Boase's street-sweeping machine (England, 1831) had 5 rows of brushes spirally arranged on an axis which is rotated by bevel-gear from the main axle. It delivers the sweeping in a ridge at the off-side of the machine.

The street-sweeping machine adopted in the municipal service of Paris has a broom attached to the rear of a two-wheeled vehicle, by means of a framework, which is so hinged to the axle of the vehicle as to enable the conductor upon the box in front to raise it out of contact with the pavement, or to depress it for service at pleasure.

Upon one of the wheels of the vehicle is fixed a conical gear-wheel, which drives a pinion running on an axis inclined about 20 degrees to the axis of the vehicle; and this axis is connected with the axis of the broom by a chain working in a pair of rag-wheels. The axis of the broom itself is inclined so as to be parallel to the axis of the pinion just mentioned, and therefore oblique to the direction of movement. When the broom is applied to the pavement the rag-chain gives it a rotation opposite to that of the wheels of the vehicle; and the dust or mud of the street is swept on before it and turned aside, so as to form a continuous heap parallel with the axis of the road.

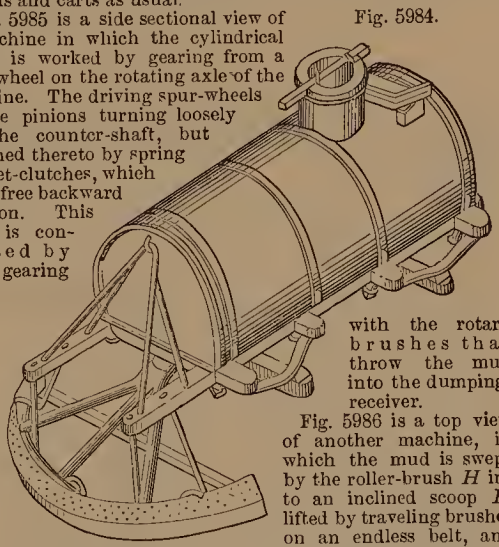
Fig. 5983.



*Dummy.*

The broom is armed with stout splints, and is 2 feet in diameter. In length it is about 6 feet. It leaves a track cleanly swept behind it of nearly this breadth. The dust is left in a ridge, or, as we should say, in wind-row, and is removed by shovels and carts as usual.

Fig. 5984.



*Street-Sprinkler.*

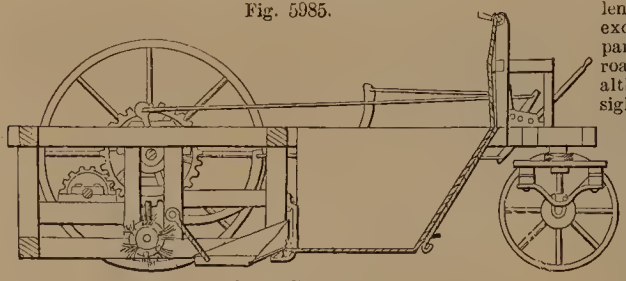
Fig. 5985 is a side sectional view of a machine in which the cylindrical brush is worked by gearing from a spur-wheel on the rotating axle of the machine. The driving spur-wheels engage pinions turning loosely on the counter-shaft, but clutched thereto by spring ratchet-clutches, which allow free backward rotation. This shaft is connected by chain gearing with the rotary brushes that throw the mud into the dumping-receiver.

Fig. 5986 is a top view of another machine, in which the mud is swept by the roller-brush *H* into an inclined scoop *E*, lifted by traveling brushes on an endless belt, and deposited in the box *I*. From thence it is dumped when the machine has been driven to the place of deposit.

Fig. 5987 is a machine for removing the dirt from close to the curbstone, and leaving it where an ordinary machine may reach it. The brooms and brushes are so connected by shafts and gearing with the ground-wheels as to revolve in a direction at right angles to the direction of motion of the machine.

Fig. 5988 shows, by a longitudinal section, a machine having

Fig. 5985.



*Street-Sweeper.*

an endless belt with brushes. The belt is moved by gear connection with the ground-wheels.

Fig. 5989 has a pair of oblique brushes to gather a wide swath of dirt into a position to be swept up by the succeeding cylindrical brush.

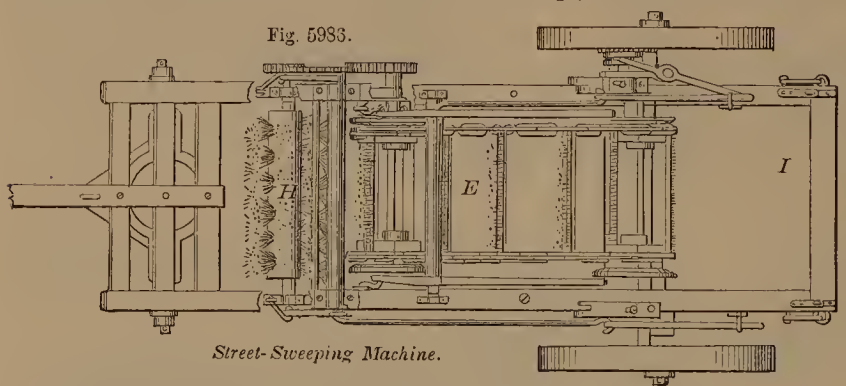
Ancient Rome had its cloacæ, and so had its beautiful colony Augsburg; but the cleaning of streets, except in exceptional cases, as in the splendid capital of the Spanish Caliphs, Cordova, was in a beastly state of inefficiency.

In Paris, in 1285, under Philip the Bold, an order was issued that each citizen should keep the street clean in front of his own house. In 1348 and 1388 stringent penalties were enacted against the remiss, and a dirt and garbage cart (*un tombereau*) was established. About the end of the fourteenth century the scavenger business became a regular trade. The government took charge of it in 1609, letting it out in contracts.

The work has changed somewhat in its character by the introduction of SEWERS (which see) and by other sanitary regulations and arrangements.

Without descending to the full particulars, we may state that every kind of filth was habitually thrown into the street until comparatively modern times. Swine were forbidden to run loose in Paris in 1131, in consequence of the death of the young King Philip by a fall, owing to one of these animals running between the legs of his horse. By an ordinance of 1395 the throwing of filth into the streets was prohibited in Paris. It is only 120 years since this filthy practice was in full vogue in Edinburgh.

Fig. 5986.




*Street-Sweeping Machine.*

**Street-wash'er.** A name sometimes given to a hydrant or fire-plug from which the street may be sprinkled or washed, by a jet from hose and nozzle.

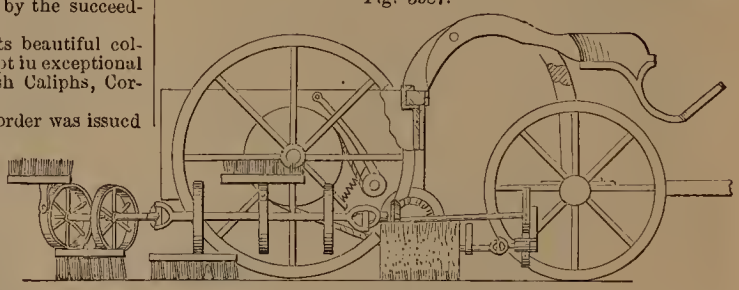
An invention for this purpose was introduced into Glasgow, in April, 1858, by Mr. Sim. On one side of the roadway, pipes were laid next the pavement, and connected with the water-main. The pipes were drilled with holes one tenth of an inch in diameter. On turning the water on from the main, it squirted across the street, completely and speedily watering, and, if required, washing the roadway.

"Engineering" describes a new process for "laying the dust" in streets, devised by a Mr. Cooper, who, amongst other contracts, undertook the watering for the parish of Marylebone, one of the largest in London, at a reduction of some fifty per cent on the other tenders. Mr. Cooper's system of watering is based upon the principle of utilizing the moisture always suspended in the atmosphere, by saturating the roads with a solution of deliquescent salts. Upwards of one million gallons of the solution have been distributed over various lengths of road with important and incidental advantages, exclusive of the enormous saving in water and labor. Apparently a sort of concrete is formed of the detritus of the road surface and the chemicals employed in the solution; for, although a road watered on this system may appear at first sight to be perfectly dry, upon closer inspection it will be seen that the dust is concreted together in masses too large to be blown about by the wind.

It is stated that the chemicals employed in the above solution have proved very destructive to the hoofs and feet of horses. *Quien sabe*

**Strength of Ma-te'ri-als.** The strength of materials is determined in three ways, — by their resistance to a *crushing* force, a *tensile* force, or by a *tortional* force. Of these tests, the former two possess the most general utility, as compressive or tensile strains are those to which materials are most frequently subjected in structures of any kind.

Fig. 5987.



*Street-Sweeping Machine.*

The reader is referred to Barlow, "On the Strength of Materials." Consult, also, "Ordnance Manual," ed. 1861, and technical works on building, civil engineering, iron working and manufacture, etc. See TESTING-MACHINE.

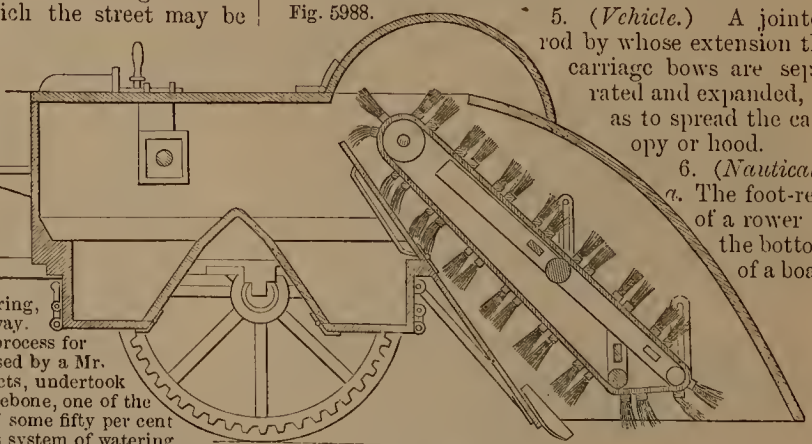
**Stretch'er.** 1. (*Bricklaying.*) A brick whose length is laid in the direction of the length of the wall.

2. One of the extension-rods of an umbrella, attached at one end to the sleeve which slides on the handle, and at the other end to a rib of the frame.

3. (*Carpentry.*) A tie-timber in a frame.

4. A round rail joining the legs of a chair. A *round.*

Fig. 5988.



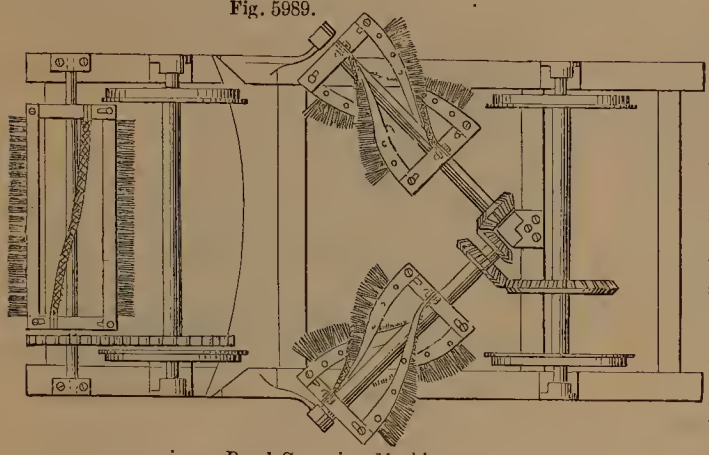
*Street-Sweeping Machine.*

5. (*Vehicle.*) A jointed rod by whose extension the carriage bows are separated and expanded, so as to spread the canopy or hood.

6. (*Nautical.*) *a.* The foot-rest of a rower at the bottom of a boat.

*b.* A cross-piece to keep the sides of a boat distended when slung to get on board or overboard.

Fig. 5989.



*Road-Sweeping Machine.*

7. A tool for expanding gloves.

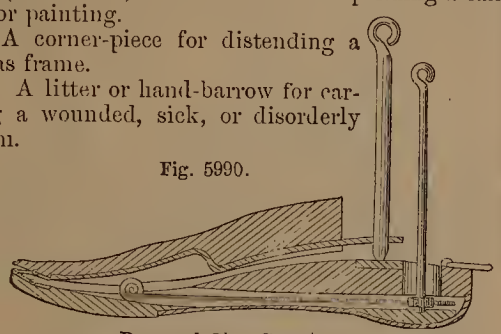
8. (*Shoemaking.*) An expanding last for distending shoes.

9. (*Fine Arts.*) *a.* A frame for expanding a canvas for painting.

*b.* A corner-piece for distending a canvas frame.

10. A litter or hand-barrow for carrying a wounded, sick, or disorderly person.

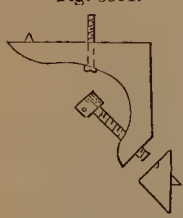
Fig. 5990.



*Boot and Shoe Stretcher.*

It is in great request at the front during an action, for carrying off the wounded to the rear, to a field hospital, or to ambulances for transportation farther to the rear. It is usually like a hand-barrow, with a bottom made of sacking, nailed to the frame. Some have legs, and some have none. Those with folding-legs pack more compactly for transportation.

Fig. 5991.



*Stretcher for Painters' Canvas.*

A number were patented during our late war. Fig 5992 shows one which may be folded for transportation, is mounted on wheels and springs and on folding-legs, and its bed portions are adaptable to the necessities of varying cases.

Stretchers are also used for conveying dangerous persons to a place of safety; mad, drunk, or ferocious, to asylum, jail, police-station, or guard-house. See LITTER; BIER; HAND-BARROW.

**Stretch'er-mule.** (*Cotton-manufacture.*) A mule adapted to stretch and twist fine rovings of cotton, bringing them forward another stage in respect of attenuation and twisting. See MULE.

**Stretch'ing-course.** (*Masonry.*) A course of stones or bricks laid with their longest dimensions in the direction of the length of the wall. See BOND.

**Stretch'ing-frame.** (*Cotton-manufacture.*) *a.* A machine in which rovings are stretched in the process of converting them into yarn.

*b.* A long frame on which starched muslins are stretched and exposed in a warm room to dry. It is the substitute for the cylinder drying-machine, which is used upon heavier classes of goods.

To give the *patent finish*, the sides of the frame are moved backward and forward, so as to give a diagonal stretch in alternate directions to the cloth This is continued until dry, and the effect is a soft and elastic finish, resembling clear-starching.

**Stretch'ing-ir'on.** (*Leather-working.*) A currier's tool, resembling a *slicker*, consisting of a flat piece of metal or stone fixed in a handle and used to scrape the surface of curried leather, to stretch it, reduce inequalities, and raise the *bloom*,—a certain powdery appearance which marks the surface of well-tanned leather.

**Stretch'ing-ma-chine'.** A machine for stretching textile fabrics so as to lay their warp and woof yarns in truly parallel positions.

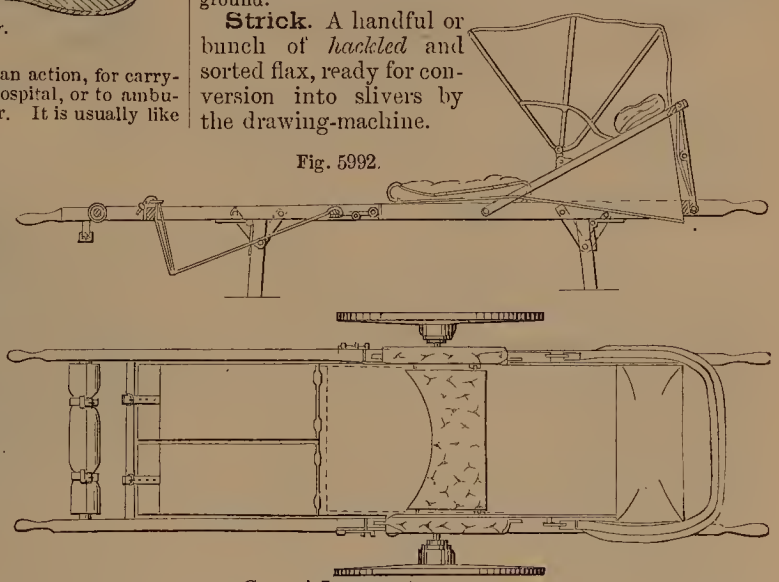
An ingenious and effective machine for this purpose, patented by Morand of Manchester, is described in Newton's "London Journal of Arts and Science" for December, 1835. See also TENTERING-MACHINE.

**Striæ-de-tect'or.** An instrument invented by Professor Töpler of Riga for detecting the streaks or striæ in glass-disks, caused by irregularities of density. These are sometimes of sufficient magnitude to be visible on simple inspection, but when not so, they render the glass unfit for optical purposes.

The instrument consists of a lamp before which is placed an opaque disk having apertures of various dimensions, enabling the observer to vary the size of the radiant at pleasure. The light is thrown on a large lens of short focus, and passes through the glass to be examined. Exactly at the focal point is placed an opaque disk of the exact size of the image there formed. If the lens to be tested is perfect, a complete eclipse will take place, but if irregularities exist they will cause the rays falling on them to deviate from the focal point, and will produce an image of their figure apparently more or less bright upon a dark ground.

**Strick.** A handful or bunch of *hackled* and sorted flax, ready for conversion into slivers by the drawing-machine.

Fig. 5992.



*General Tompkins's Stretcher.*

A cwt. (112 lbs.) of flax makes 300 to 400 *stricks*.

**Strick'le.** 1. (*Carpentry and Masonry.*) A pattern or templet.

2. (*Founding.*) *a.* A semicircular piece of wood used in smoothing molds of loam to form cores for curved and crooked pipes; also for spreading upon the cores a thickness of loam answering to the required thickness of the pipe. The core and its envelope form a model in the sand-flask, and are then removed; the outer thickness of loam is removed, exposing the core; this is placed in the mold, resting on

Fig. 5993.

*Stretching-Iron.*

prints; the mold is closed, clamped, and the metal poured.

*b.* A straight-edge of wood with which to remove superfluous sand from a flask after ramming up.

2. (*Cloth-shearing Machines.*) A straight-edge fed with emery and employed to grind the edges of a series of knives arranged spirally on a cylinder.

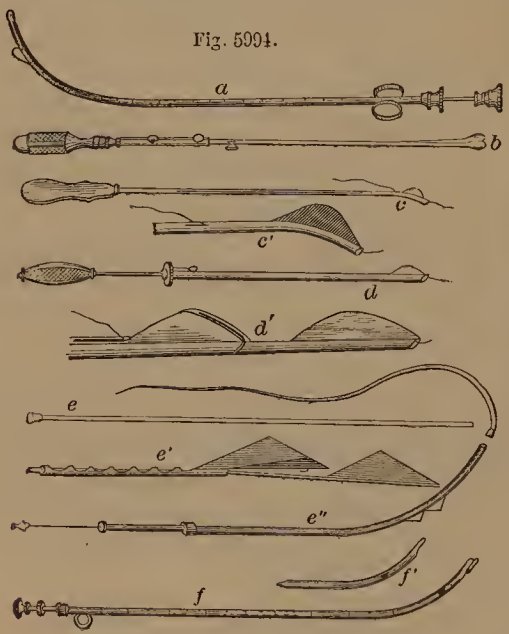
3. A straight-edge to strike grain to a level with the upper edge of the measure. A *strike.*

4. An instrument for whetting scythes. A *rifle.*

5. (*Flax.*) A *strike* or sword used in dressing flax.

**Strict'ure-cut'ter.** An instrument for dividing contractions of the urethra. A catheter concealing

Fig. 5994.

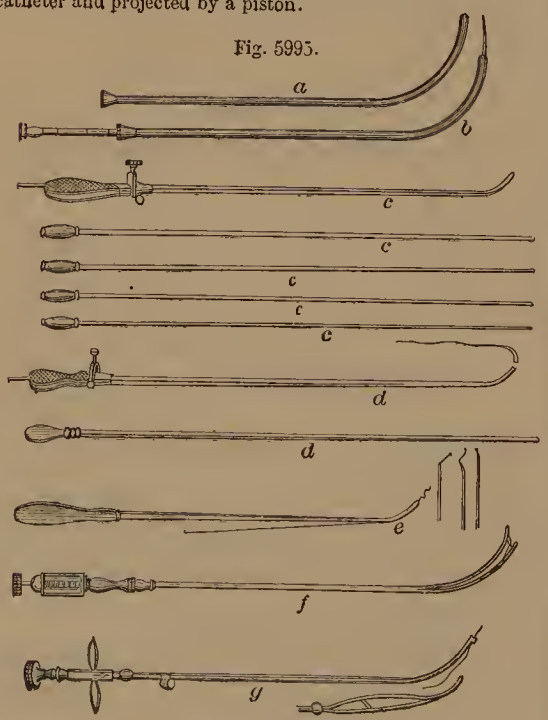



*Tiemann's Stricture-Cutters.*

a knife, which may be pushed out at the proper time, dividing the stricture without injuring any other part of the urethra.

*a* is Peters's instrument, having a lancet concealed in the catheter and projected by a piston.

Fig. 5995.




*Stricture-Dilators.*

*b* is Civiale's, having spoon-shaped terminals concealing the knife.

*c* is Gouley's. *c'*, an enlarged view of a portion.

*d* is another of Gouley's. *d'*, an enlarged view, showing the lancet projected from the sheath.

*e e' e''* are Volimier's instruments.

*f f'*, Martin's instrument.

**Strict'ure-di-lat'or.** An instrument for relieving contractions in the urethra, by *tearing.*

*a b* are views of Miner's instrument, one showing the probe projected.

*c c c c c* are Holt's instruments, of different diameters, for consecutive use in expanding the walls of the urethra.

*d d'* is Bumstead's dilator.

*e* shows dilators of varying forms, with whalebone guide.

*f* is an expansible bifurcated instrument.

*g*, Sir Henry Thompson's instrument, with expansible stem section.

**Strig'il.** 1. An instrument formerly used in baths for scraping off the sweat, but more specifically useful in exciting the action of the skin and tissues beneath.

Fig. 5996.

*Strigils.*

2. A flesh-brush.

**Strike.** 1. (*Brick-making.*) A small piece of wood about $1\frac{1}{2}$ in. × $\frac{1}{2}$ in., and 10 inches long, used to remove the superfluous clay from the mold.

2. A similar strip is used in measuring grain, and hence the term *struck* measure as distinguished from *heaped* measure. Customs vary in this respect, and the practice of selling by weight is superseding the old mode. See STRICKLE.

3. (*Founding.*) *a.* A hook in a foundry to hoist the metal.

*b.* A paddle or straight-edge. See STRICKLE.

4. (*Metal-working.*) A puddler's stirrer. A *rabble.*

5. (*Flax-working.*) A handful of flax that may be *struck* at once.

6. (*Sugar-making.*) The quantity of sirup, the contents of the last-pan, emptied at once into the coolers.

7. An iron pale or standard in a gate or fence.

8. (*Mining.*) *a.* The prolongation or extension of a stratum in a direction at right angles to the *dip.* The strike is also called the *line of bearing.* If a stratum *dip* to the N., the *strike* is E. and W.

Of the horizontal *drifts* of a mine, one set follows the strike of the vein and the other is at right angles to it. The former are for working the vein, the latter for removing the ore and draining the mine.

*b.* The intersection of a vein with the surface. The place where the vein *crops out.*

**Strike-or-si'lent.** (*Horology.*) A piece in a clock which sets the striking parts in or out of action. In the latter case, it pushes the warning piece clear of the pin in the hour-wheel, so that the latter, the prime agent in the striking, is allowed to revolve without setting in motion the train of parts which affect and regulate the striking.

In the *strike* position, the pin on the hour-wheel is effective in moving the warning-piece, so that the clock strikes the hour regulated by the *snail.*

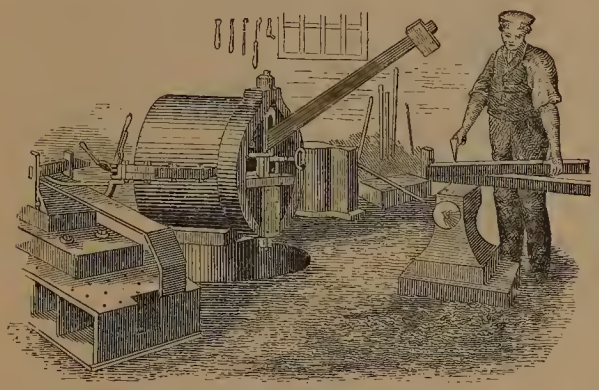
**Strik'er.** 1. (*Forging.*) A species of steam-hammer, striking in a manner similar to the trip-hammer, but operated directly from the engine, the cam-wheel being dispensed with. It may be adjusted to strike either vertically, or horizontally, or at any angle, and is designed as a substitute for the blacksmith's assistant, known as the *striker,* on heavy work.

Fig. 5997. Position for vertical blows.

Fig. 5998. *a* shows it in position for *upsetting,* delivering horizontal blows.

*b.* Position for blows at an angle of 45°, for bending angle-iron and T-stiffeners.

Fig. 5997.

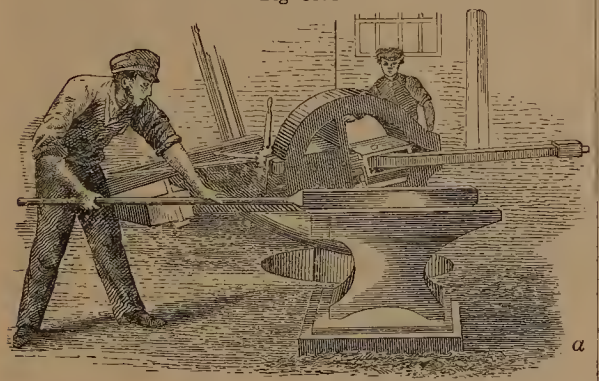


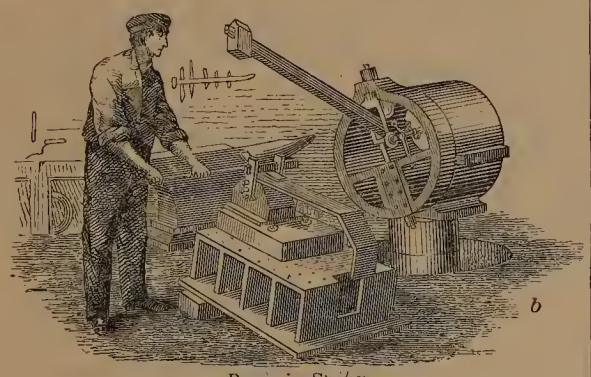
*Striker.*

The operator can regulate the force, direction, or rapidity of blows by actuating a foot-valve projecting through the floor, near the anvil. They can be arranged for working by compressed air or water-pressure, but are usually worked by steam.

2. A hardened mold or former upon which a softened steel block is struck, to receive a concave

Fig. 5998.




*Davies's Striker.*

impression from the *striker*. *Swages* are made in this way, the two portions receiving their grooves from a striker between them. See SWAGE.

3. A harpoon.

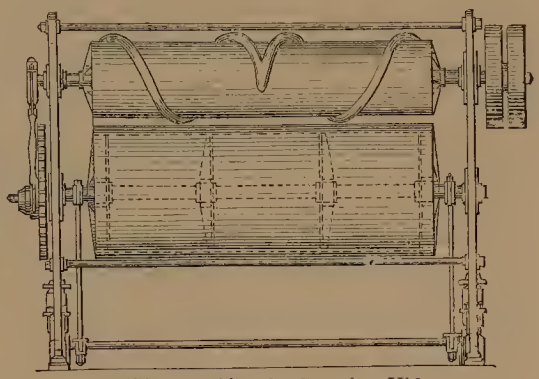
**Strik'ing.** 1. (*Architecture.*) The removal of a center upon which an arch has been built. It is done by striking the wedges on which the ribs rest. See CENTERING.

2. (*Joinery.*) Running a molding with a molding-plane.

**Strik'ing-knife.** When hides are taken from the last pit of tanning-liquor they are washed and dripped, being occasionally placed upon a long cylindrical horse and *struck* or smoothed with a triangular steel knife, which brings a bloom to the surface.

**Strik'ing-ma-chine'.** 1. (*Leather.*) One for

Fig. 5999.



*Striking-Machine for Scraping Hides.*

scraping hides. The hide, being laid upon the lower of two rollers, is gradually allowed to pass beneath the upper roller, which carries a sharp-edged spiral knife. The lower roller, being supported on springs, maintains a uniform but yielding pressure, and adapts itself to the varying thickness of the hide, the knife in the mean time scraping out the *bloom* on the hide.

2. (*Metal-working.*) A machine for stamping metals. See STRIKING-UP PRESS.

**Strik'ing-plate.** (*Carpentry.*) The device by which the wooden centering of an arch is lowered when the arch is completed.

The upper plate *a*, notched on the lower side, serves as a base for the framing of the center, and the lower plate *b*, notched on the upper side, rests on the pier or posts which support the whole. The two are separated by the compound wedge *c*, which is secured by keys. When these keys are driven out, the wedge *c* is free to slide backward, allowing the plate *a* and superposed framing to descend, leaving the voussoirs unsupported.

Fig. 6000.

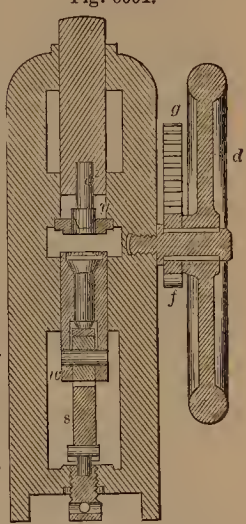
*Striking Plates and Wedges.*

**Strik'ing-up Press.** (*Sheet-metal Working.*) A press for *striking-up* or *raising* sheet-metal in making dishes, pots, pans, cups, etc. See also DROP-PRESS.

In that illustrated, the disk to be shaped is laid on the upper face of the hollow die *w*, the upward movement of which clamps it against the collar *y*, while the cameo-die $a^2$ descends and forms the object, which is afterward ejected from the matrix by a follower. The movements of both dies are derived from a rocking cam *s*, actuated from the fly-wheel *d* through gears *f g*.

See STAMPING-MACHINE.

Fig. 6001.




*Striking-Machine for Metals.*

**Strik'ing-watch.** One which indicates the time of day either automatically or in response to the pushing in of a knob. A REPEATER.

The watches of the time of Charles V. and Louis XI. had striking arrangements, and on two occasions mentioned in the chronicles of the times, thieves with the booty on their persons were detected by the striking of the watches.

**String.** 1. A cord of small diameter.

2. (*Music.*) The cord of fiber or metal whose vibrations produce the notes in instruments of the stringed class. See MUSICAL INSTRUMENTS.

"The following four laws govern the vibration of strings: The rate of vibration is inversely proportional to the length; it is inversely proportional to the diameter; it is directly propor-

tional to the square root of the stretching weight or tension; and it is inversely proportional to the square root of the density of the string. When strings of different diameters and densities are compared, the law is, that the rate of vibration is inversely proportional to the square root of the diameter of the string. The amount of motion communicated by a vibrating string to the air is too small to be perceived as sound, even at a small distance from the string. Hence, when strings are employed as sources of musical sounds, they must be associated with surfaces which take up their vibrations, and transfer them to the surrounding air. Thus the tone of a harp, a piano, a guitar, or a violin depends mainly upon the sound-board of the instrument.

"When a string vibrates as a whole, it usually divides at the same time into its aliquot parts. Smaller vibrations are superposed upon the larger, the tones corresponding to the smaller vibrations, which are known as overtones, mingling at the same time with the fundamental note of the string. It is the addition of such overtones in different proportions to fundamental tones of the same pitch, which enables the listener to distinguish the sound of a clarinet from that of a flute, and the sound of a violin from both. Could the pure fundamental tones of these instruments be detached, they would be undistinguishable from each other; but the different admixture of overtones in the different instruments renders their *timbres* diverse, and therefore distinguishable. When a stretched string is plucked aside, or agitated by a bow, all the overtones which require the point agitated for a node vanish from the clang of the string. The point struck by the hammer of a piano is from one seventh to one ninth of the length of the string from its end; by striking this point, the notes which require it as a node cannot be produced, a source of dissonance being thus avoided." — TYNDALL.

Pythagoras appears to have understood the relation of musical intervals, and is said to have stretched musical strings of equal lengths by weights having such proportion as to produce fourths, fifths, and octaves.

2. (*Mining.*) A small vein of ore, divaricating from the main vein and passing off into the rock. Still smaller veins are called threads.

3. (*Shipwrighting.*) The uppermost row of planks in a ship's ceiling, or that between the upper edge of the upper deck-ports and the gunwale.

4. A projecting course of bricks or stones in a wall. A *string-course.*

**String-block.** (*Music.*) A block in the wooden-frame piano-forte into which were driven the studs upon which the strings were looped.

It is now superseded by a *string-plate,* which has the same function, but has the advantage of metallic rigidity, as a consequence of which the strings remain longer in tune.

**String-board.** (*Carpentry.*) One of the slanting pieces of stairs into which the steps are notched.

**String-course.** (*Masonry.*) A course of brick or stone projecting slightly from the face of the wall and forming a horizontal line. It may be flat, molded, or enriched.

**Stringed In'stru-ment.** (*Music.*) An instrument whose tones are produced by the vibration of strings. See MUSICAL INSTRUMENTS.

The ancient Egyptian *harps* had 4, 6, 7, to 22 strings, and were elegantly made. Their *guitar* had 3 strings; *lyres,* 5, 7, 10, and 18. See MUSICAL INSTRUMENTS, pages 1499, 1500; list of musical instruments, page 1501; classification of instruments, pages 1500, 1501; table of compass of instruments, page 1493; HARP; PIANO; VIOLIN; etc.

**String'er.** 1. (*Carpentry.*) A horizontal timber connecting posts in a frame; as, —

A tie-timber of a truss bridge.

A horizontal tie in a floor framing.

2. (*Railway Engineering.*) A longitudinal balk or timber on which a railway rail is fastened, and which rests on transverse sleepers.

3. (*Shipwrighting.*) An inside strake of plank or of plates, secured to the ribs and supporting the ends of the beams. A *shelf-piece.*

**String-piece.** (*Carpentry.*) *a.* A horizontal connecting strip or plank of a frame.

*b.* The timber beneath a staircase which forms the soffit or ceiling.

*c.* A timber in a floor framing.

**String-plate.** (*Music.*) An iron bar in a piano-forte frame into which are inserted the studs to which the strings are secured.

**Strip.** 1. (*Mining.*) An inclined trough in which ores are separated by being disturbed while covered by a stream of water descending the *strip.*

2. (*Machinery.*) To tear the thread off a screw.

3. A narrow piece of board nailed over a crack or joint between planks.

**Stripe.** (*Weaving.*) A pattern produced by arranging the warp-threads in sets of alternating colors; or, —

In sets of varying fineness, of the same color; or,

By drawing bunches of warp-threads through the eyes of some of the heddles; or,

By passing several heddlesful through the same intervals of the reed.

A *weft* stripe crossing the warp stripe constitutes a *check* pattern.

**Strip'per.** 1. See FILE-STRIPPER.

2. (*Carding.*) A device for lifting the top flats from the carding-cylinder.

**Strip'ping.** 1. (*Carding.*) The operation of cleaning or removing the short fibers from between the teeth of the various cylinders and top flats.

Some machines are self-stripping; every other flat being moved in one motion of the stripping mechanism, the second motion taking the alternate flats.

2. (*File-making.*) The process of cross-filing and then draw-filing file blanks to prepare them for grinding or cutting.

3. Removing the *wings* of the tobacco leaf from the stems. The *wings* are piled and pressed, and form a *book.*

**Strip'ping-knife.** (*Husbandry.*) A tool for removing the blades of sorghum from the stalks, previous to grinding. See Fig. 1062, page 444.

**Strob'o-scope.** A toy depending for its effects upon the persistence of visual impressions, like the *thaumatrope* and *anorthoscope; zoetrope.* See PHENAKISTOSCOPE.

**Strock'le.** (*Glass-making.*) A shovel for frit, sand, etc. It has turned-up edges to increase its holding capacity.

**Stroke.** 1. The length of rectilinear motion of a piston, pump-rod, plunger, etc.

With a stationary engine, the motion of the piston-rod outward is the *front* stroke, the reverse is the *back* stroke. The *up* and *down* result from the position of the cylinder.

With a locomotive the *front* stroke is toward the *front* of the engine, and conversely.

The *stroke* of a valve is called its *travel* or *throw.*

The *throw* of a crank is the diameter of its circle of revolution; twice its radius.

The term *excursion* is applied in some cases; in others, the term *range.*

**Strong-sand.** (*Founding.*) That which contains a large quantity of clay, and is therefore tenacious.

**Stron'ti-um.** Equivalent, 44; symbol, Sr.; specific gravity, 2.54. This is a white, malleable metal, of but little importance in a mechanical point of view, but its salts are used in pyrotechnics to give a red glare.

**Strop.** 1. (*Rope-making.*) A rope with an eye at each end, used in twisting strands.

2. (*Nautical.*) A rope spliced into a circular wreath to seize around a block for hanging it.

3. Another name for strap, as *razor-strop.*

**Stroud.** (*Fabric.*) A coarse blanket-stuff, used in trading with the Indians.

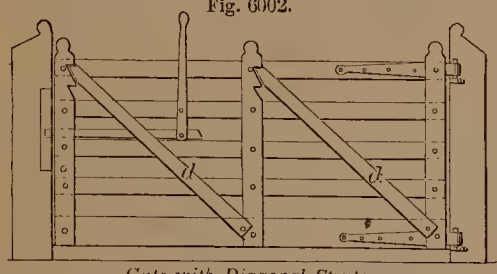
**Strun'tain.** (*Fabric.*) A coarse, narrow worsted braid.

**Struse.** (*Nautical.*) A river-craft of Russia for carrying produce and goods.

**Strut.** A bar in a frame having equal and opposite forces applied to its ends, acting inward and producing upon it a state of compression. A *tie* is a bar differently applied, its function being tensile. A bar applied to a strut to prevent lateral deviation is a *stay*. See TRUSS; ROOF; etc.

*Specifically.* *a* A diagonal timber which acts as a post or brace to support a *principal rafter* or *purlin*. Its lower end is stepped into a *tie-beam*, or on a shoulder of a *king* or *queen post*. See KING-POST TRUSS.

Fig. 6002.



*Gate with Diagonal Struts.*

*d d*, in Fig 6002, show struts to prevent the sagging of the gate.

*b*. Braces between joists. See STRUTTING.

**Strut'ting.** (*Carpentry.*) Diagonal braces between joists to prevent side deflection. See CHIMNEY.

When the pieces are crossed alternately, it is called *herring-bone strutting*.

**Stub.** 1. An old horseshoe nail. Iron formed therefrom. *Stub-iron.*

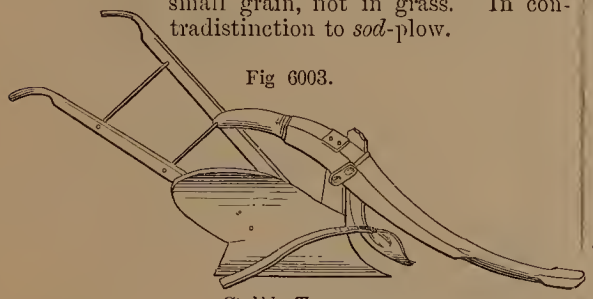
Stub-iron is used especially for gun-barrels of superior quality The stubs are put into a tumbling-box to brighten them, removing all rust and dirt They are then combined with from 12 to 50 per cent of steel in blocks of the same size as the *stubs*. The combined metals are puddled, hammered, heated, tilted, and rolled into ribbons, to be wound in coils around mandrels, heated to a welding heat, *jumped*, and finished by a hammer on the anvil. See GUN-BARREL; TWIST.

2. (*Locks nithing.*) A stationary stud in a lock which acts as a detent for the tumblers when their slots are in engagement therewith.

**Stub-ax'le.** A short axle attached on the end of a principal axle-tree. It is variously made and secured. Sometimes it is a sort of *jury* axle, made as a temporary expedient when the arm of an axle has broken off. It occurs frequently on horse hay-rakes and some other kinds of agricultural implements.

**Stub'ble-plow.** (*Husbandry.*) One for plowing *old* ground, so called; land which was lately in small grain, not in grass. In contradistinction to *sod*-plow.

Fig 6003.



*Stubble-Turner.*

**Stub'ble-rake.** (*Husbandry.*) A rake for gleaning lately reaped fields of small grain; wheat, rye, oats, or barley.

**Stub'ble-turn'er.** An attachment to a plow to turn over stubble and trash before the principal plow reaches it. In the example, the stubble-turner is attached to the point of the coulter and curves over in front of the mold-board.

**Stub-end.** (*Machinery.*) The enlarged end of a connecting-rod, in which the boxes are confined by the strap.

**Stub-mor'tise.** (*Carpentry.*) A mortise which does not pass through the object in which it is made; not a *through* mortise.

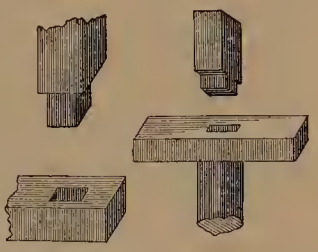
**Stub-nail.** A short thick nail.

**Stub-short; Stub-shot.** 1. The unsawed portion of a plank where it is split from the bolt or log. The saw-kerf reaches nearly to the end of the log, in *gig-back* saws; the plank is then split off the remainder of the distance: this remainder forms a short *stub*.

2. (*Turning.*) The portion by which an object to be turned is grasped or chucked. It projects beyond the ultimate surface of the object, and is cut off when the shaping is finished.

**Stub-ten'on.** (*Carpentry.*) A short tenon at the foot of an upright, such as the scantling or studding of a partition or a floor-bearer.

Fig. 6004.



*Stub-Tenon.*

**Stub-twist.** A gun-barrel made of a ribbon of combined iron and steel, the iron being derived from stubs (old horseshoe nails.) See STUB.

**Stuc'co.** (*Plastering.*) *a*. Plaster for coating walls. It is usually made of pure lime slaked and settled, mixed with clean sand.

Stucco varies in quality and composition with the purpose for which it is intended. Gypsum and pounded marble sometimes enter into its composition, as well as gelatine or glue in solution.

One recipe gives 3 to 4 volumes of white sand, and 1 volume of fine stuff or lime putty.

*b*. The third coat of plastering when prepared for painting.

*Troweled* stucco is of the best description.
*Bastard* is a coarser kind.
*Rough* stucco is the coarsest kind prepared for painting.

**Stück-fur'nace.** (*Metallurgy.*)

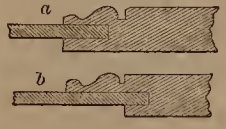
The stück furnace or Wolf's oven is a furnace for the reduction of iron, at one time common in Europe, now little employed. The interior of this furnace has the form of two cones united at their bases: it is usually from 10 to 16 feet high, 24 inches wide at bottom and top, and 5 feet at the center. There are generally two tuyeres, both on the same side. The opening called the breast is closed after the furnace is heated. after which charcoal and ore are thrown in, and the blast introduced. As soon as the ore passes the tuyere, iron is deposited at the bottom of the hearth; when this amounts to a ton, the blast is stopped, the breast-wall removed, and the metal lifted out in a solid mass, or *stuck*, *wulf*, as it is called by the Germans.

**Stuck-on.** (*Carpentry.*) A term indicating a molding worked on the edge of a frame; in contradistinction to one worked out of a detached strip.

*a*, *stuck-on*.
*b*, *laid-on*.

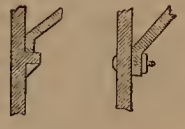
The operation of shaving down the arris is called *sticking*, *striking*, or *running* the molding.

Fig. 6005.




*Stuck-On.*

Fig. 6006.



*Studs.*

**Stud.** 1. (*Machinery.*) A boss or protuberance designed to hold an attached object in place.

2. (*Carpentry.*) An upright scantling.
3. (*Wear.*) A button with a shank and disk.
4. A nail with a large head.
5. (*Nautical.*) A cast-iron brace across the minor diameter of a cable link, to prevent collapse.

**Stud'ding-sail.** (*Nautical.*) An additional sail spread by the aid of light booms beyond the *leech* of a square sail; in order to extend the area horizontally, in light winds. They may be added on both leeches of a square sail.

The prolongation of the yard by which a *studding-sail* is extended is a *studding-sail boom*, which is supported by hoops on the yard called *quarter-irons* and *yard-arm irons*. See YARD.

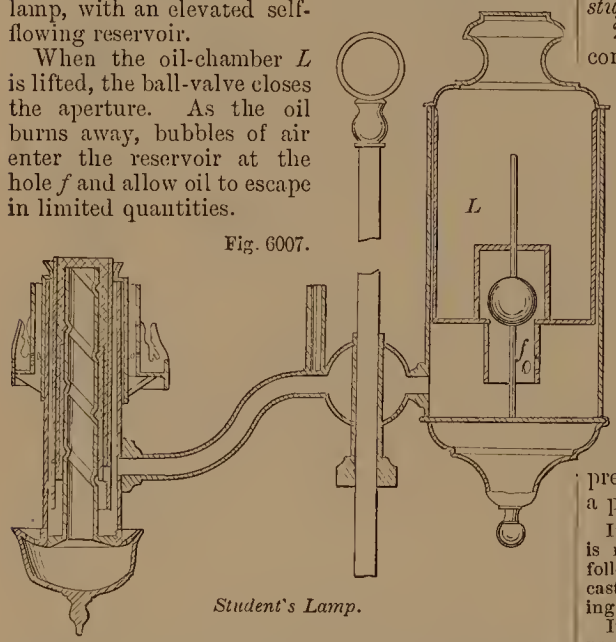
It is *rigged-out* by a *twofold purchase* called a *boom-jiggar*.

**Stud'ding-sail Yard.** A spar rigged out from the end of a yard, to stretch a studding-sail.

**Stu'dent's Lamp.** A form of argand-burner lamp, with an elevated self-flowing reservoir.

When the oil-chamber *L* is lifted, the ball-valve closes the aperture. As the oil burns away, bubbles of air enter the reservoir at the hole *f* and allow oil to escape in limited quantities.

Fig. 6007.




*Student's Lamp.*

**Stud-work.** (*Building.*) Brickwork between studs. An old form of building once common in England and lately introduced into the United States by admirers of the ancient and picturesque.

**Stuff.** 1. (*Nautical.*) A melted mass of turpentine, tallow, etc., with which the masts, sides, and bottom of a ship are smeared.

2. (*Paper.*) Paper-stock, ground ready for use. When half ground it is known as *half-stuff*.

3. (*Fabric.*) An all-wool plain dress-goods for ladies.

4. (*Mining.*) Attle or rubbish.

5. (*Leather.*) A composition of fish-oil and tallow for filling the pores of leather. *Dubbing.*

**Stuff-chest.** (*Paper-making.*) The vat where the pulps from the engines are mixed and combined preparatory to molding by hand or machinery.

**Stuff-en'gine.** (*Paper-making.*) A pulp-grinder. See Figs. 4015 – 4020.

**Stuff'er.** A machine for packing or filling; as,

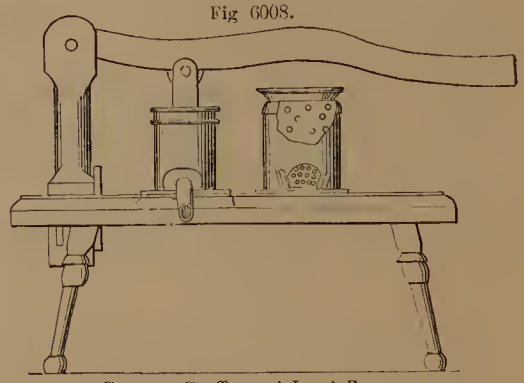
1. A machine for stuffing horse-collars.

2. A SAUSAGE-STUFFER (which see). In Fig. 6008, the sausage-reservoir is fixed to a block let into a recess of the table, so that it can be easily slipped out and the lard-vessel be substituted in its place.

3. A machine for saturating leather with *dubbing* in one part of the operation of leather-dressing.

**Stuff'ing.** 1. (*Leather.*) A mixture of fish-oil and tallow which is rubbed into leather after being

Fig 6008.



*Sausage-Stuffer and Lard-Press.*

*shaved* by the currier's knife, and previous to the *boarding* or *graining*. The tool used is called a *stuffer*.

2. (*Fiber.*) Filling for cushions and mattresses, consisting of cotton, flocking, hair, wool, cork, sponge, hay, straw, tow, flax, moss, curled shreds of wood (*Excelsior*), etc.

**Stuff'ing-box.** (*Machinery.*) *a.* A box with an annular recess around a piston-rod, and provided with a follower and bolts, whereby the packing may be screwed down.

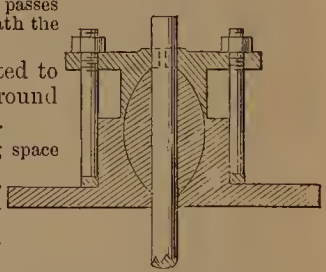
The invention of Sir Samuel Morland, an experimenter who lived in the interval between Newcomen and Watt, 1710 – 1761.

Two notable instances are: —

Around the piston-rod where it passes through the cylinder-cover; and

Around the screw-shaft of a steam-vessel where it passes through the stern beneath the water.

Fig. 6009.



*Metallic Packing for Piston-Rods.*

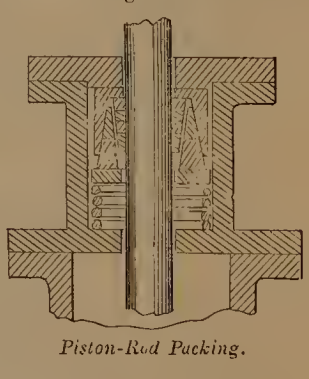
*b.* A sleeve adapted to press a collar of hemp around a piston-rod. A *gland*.

In Fig. 6009, the packing space is made elliptical, and the follower is perforated for casting in soft alloy as packing.

In Fig. 6010, a spring presses against the conical follower and drives the packing-rings against the piston.

The stuffing-boxes in a locomotive-engine are recesses for admitting some soft material, such as white spun-yarn, to render steam-tight any rod working through this stuffing or packing. The piston-rods, slide-valve rods, regulator-rods, and pump-plunger, all work through stuffing-boxes of this description.

Fig. 6010.



*Piston-Rod Packing.*

**Stuff-shov'el.** The paper-maker's shovel for handling materials.

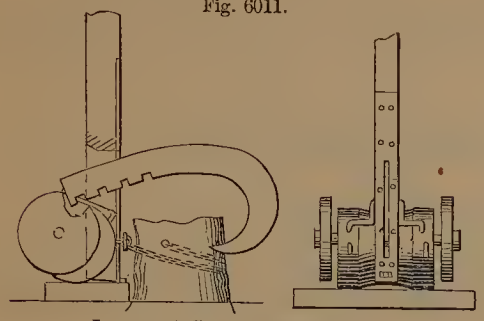
**Stull.** (*Mining.*) Timber placed in the back of a level and covered with boards or small poles to support rubbish.

**Stump.** 1. (*Locks.*) A projection, generally stationary, variously employed as a support for a dog, fence, or tumbler, as an obstruction to prevent the improper retraction of the bolt, or as a guide for any of the moving parts.

2. An artist's soft rubber, for blending or scumbling.

**Stump-ex-tract'or.** 1. (*Agriculture.*) A tool or machine for pulling the stumps of trees from the ground, in order to remove them from interference with cultivation.

Fig. 6011.

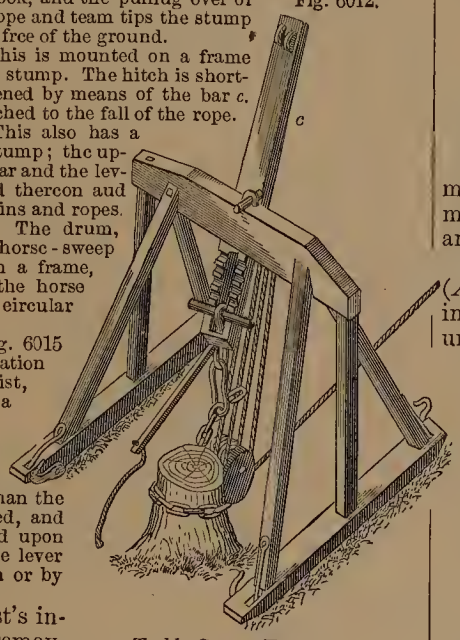


*Lever and Claw Stump-Extractor.*

There are many varieties, of which six may be mentioned as typical: —

1. The *lever and claw*. In the example of this, the lever is mounted on strong wheels, which act as a fulcrum for the lever. The claw is caught over the stump, in manner of a cant-hook, and the pulliug over of the lever by a rope and team tips the stump over and lifts it free of the ground.

Fig. 6012.




*Tuckle Stump-Extractor.*

2. *Tackle*. This is mounted on a frame erected over the stump. The hitch is shortened or lengthened by means of the bar *c*. The team is hitched to the fall of the rope.

3. *Toggle*. This also has a frame over the stump; the upright hoistiug-bar and the levers are arranged thereon aud operated by chains and ropes.

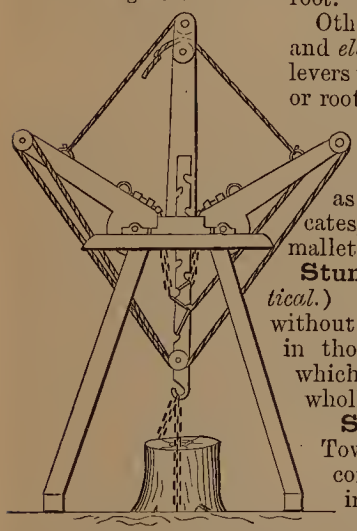
4. *Windlass*. The drum, gearing, and horse-sweep are arranged on a frame, around which the horse walks in a circular path.

5. *Screw*. Fig. 6015 shows an application of a screw hoist, mounted on a wagon.

6. *Capstan*. The capstan is anchored to a firmer stump than the one to be pulled, and the chain wound upon the barrel as the lever revolves by team or by hand.

2. A dentist's instrument for removing the stumps and roots of decayed teeth. They are of various forms. The *screw* is driven into the nerve cavity, and serves to withdraw the root.

Fig. 6013.



*Toggle Stump-Extractor.*

Other tools are *gouges* and *elevators*, which act as levers to pry out the stump or root.

The *hook* is another form.

The *punch* operates, as its name indicates, by the blow of a mallet.

**Stump-mast.** (*Nautical.*) A lower mast without tops. Common in those steam-vessels which never depend wholly upon sails.

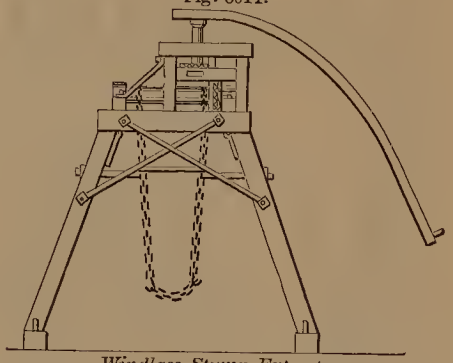
**Stu'pa.** (*Surgical.*) Tow used as a pledget, compress, or as a wad in fomentations.

**Style.** 1. (*Architecture.*) A name by which the more modern systems of architecture are known, in contradistinction to the Grecian and Roman *orders*.

2. A hard point for tracing, in manifold writing. See PEN.

3. The gnomon of a sun-dial.

Fig. 6014.



*Windlass Stump-Extractor.*

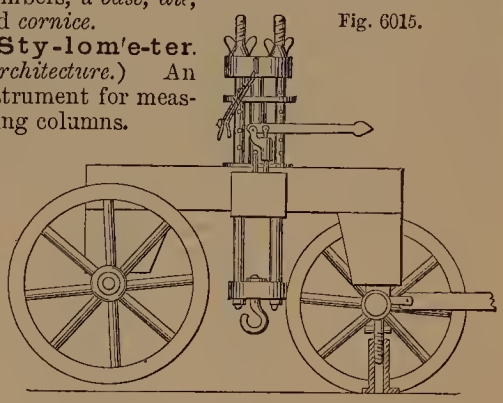
**Sty'let; Sty'lus.** 1. A *probe*.

2. A pencil or marker.

**Sty'lo-bate.** (*Architecture.*) A continuous basement beneath a row of columns or façades. It has 3 members, a *base*, *die*, and *cornice*.

**Sty-lom'e-ter.** (*Architecture.*) An instrument for measuring columns.

Fig. 6015.



*Screw Stump-Extractor.*

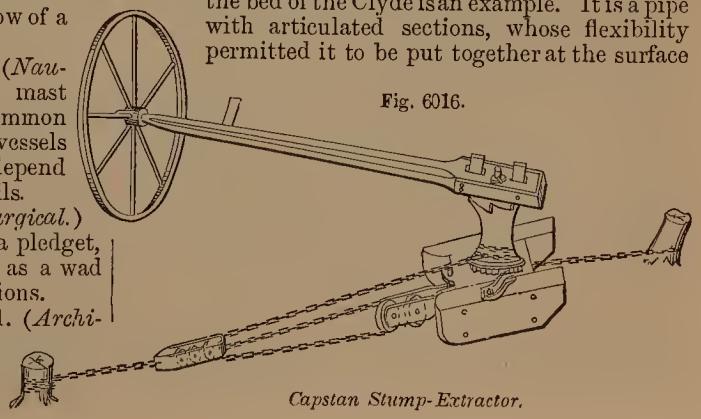
**Stythe.** (*Mining.*) Choke-damp, or carbonic-acid gas.

**Sub.** (*Well-boring.*) A short name for *substitute*. A short section of rod for connecting tools or bars of different sizes. See WELL-BORING TOOLS.

**Sub-a'que-ous Hel'met.** A diver's head-dress, supplied with air by pump from above. See ARMOR, SUBMARINE, pages 155–157; DIVING-BELL, pages 713–715; RESPIRATOR, page 1923.

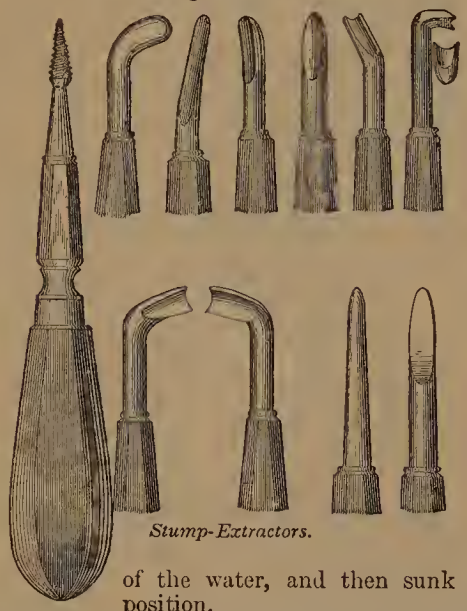
**Sub-a'que-ous Tube.** A pipe or tunnel (according to size) laid beneath the water as an aqueduct or viaduct. James Watt's submerged aqueduct across the bed of the Clyde is an example. It is a pipe with articulated sections, whose flexibility permitted it to be put together at the surface

Fig. 6016.



*Capstan Stump-Extractor.*

Fig. 6017.

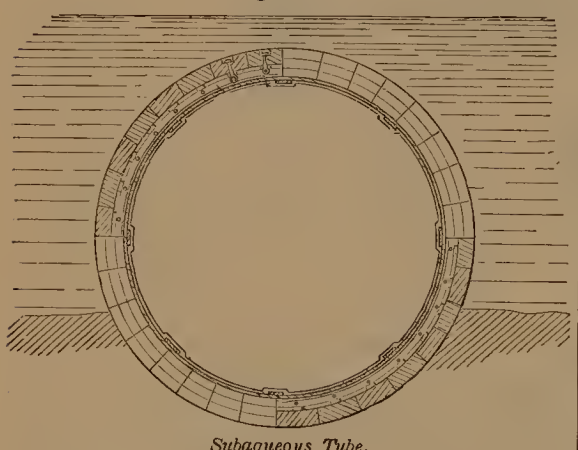


*Stump-Extractors.*

of the water, and then sunk into position.

Fig. 6018 shows a submerged tube whose onter easing of cement in form of blocks is attached by bolts, whose forked ends are riveted to rings of angle-iron surrounding the metallic part

Fig. 6018.



*Subaqueous Tube.*

of the tube. The blocks are connected together by tongues and grooves.

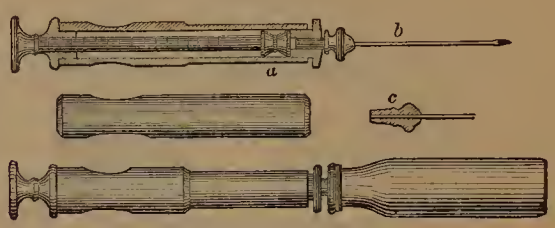
**Sub-cal'i-ber Pro-jec'tile.** (*Ordnance.*) A projectile for cannon or small-arms, of smaller diameter than the bore of the gun from which it is fired, but having a sabot large enough to fill the bore, allowing the usual windage; or with an expanding sabot, which is forced out so as to fill the bore when the gun is fired.

**Sub'cu-ta'ne-ous Saw.** A saw by which bony sections may be made without large incisions in the flesh. It may be compared to a probe, a portion of whose length, at and toward the end, is flattened and serrated, so that being driven in to the seat of its operations, it is reciprocated, so as to cut the bone without mangling the flesh to any serious extent.

**Sub'cu-ta'ne-ous Syr'inge.** (*Medical.*) An instrument for injecting medicinal solutions beneath the skin. It consists essentially of a tube with a piston for containing the preparation, and a perforated needle for piercing the skin, and through which the fluid is injected. Also called a *dermopathic syringe.*

Fig. 6019 is an improved form by Leiter of Vienna. In this, the lower end of the tube *a* is conically enlarged, for the more ready introduction of the lancet or needle *b* and the plug *c*, by

Fig. 6019.




*Subcutaneous Syringe.*

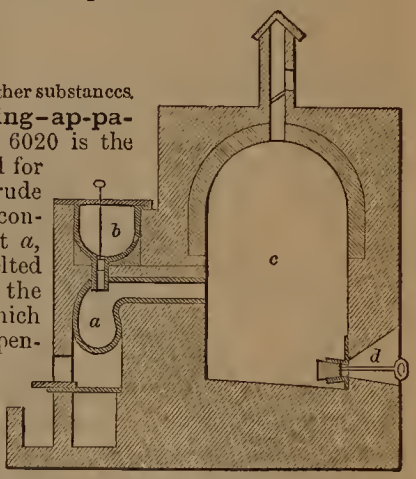
which it is secured in the tube. The piston-handle is graduated, that a definite amount of fluid may be drawn into the tube. See HYPODERMIC SYRINGE; ACUPUNCTURATOR.

**Sub-li-ma'tion.** A heating process by which solids are converted into vapor and again condensed, often in the crystalline form.

This process is adopted with

Mercury,
Zinc,
Arsenic,
Sulphur, and other substances.

Fig. 6020.




*Sulphur-Sublimator.*

**Sub-lim'ing-ap-pa-ra'tus.** Fig. 6020 is the apparatus used for purifying crude sulphur. This consists of a retort *a*, filled with melted sulphur from the reservoir *b*, which has a valved opening at bottom.

The retort is heated by a furnace beneath, and as the sulphur is vaporized it passes over into the chamber *c*, where it condenses in the form of flowers of sulphur. After a few days' working, the walls of the chamber become sufficiently hot to fuse these as they condense, and the sulphur is then withdrawn from time to time through the plugged opening *d* and run into molds. See also ARSENIC-FURNACE, Fig. 373, page 162; CONDENSER, Fig. 1420, page 608.

**Sub'ma-rine' Ap-pa-ra'tus.** A device to enable persons to work under water.

The diving-bell is said to have been used among the Greeks in the time of Aristotle. It was first introduced into Western Europe near the beginning of the sixteenth century, but was not made practically available for use at considerable depths until Dr. Halley, in 1715, invented the method of displacing the water which entered the lower part of the bell by submerging casks containing air to a level a little below the bell, and discharging the air from them into it by admitting water at their bottoms by means of cocks. He also contrived a headpiece, open at the lower part, which enabled a diver to leave the bell and make explorations outside, being supplied with air through a flexible tube leading into the bell. Spalding subsequently divided the bell into an upper and a lower chamber, the former to be wholly or partially filled with water, and serving to regulate the buoyancy, while the latter was occupied by the divers. By admitting air from the barrels into the lower chamber and opening a cock connecting the two chambers, the upper could be filled with air, causing the apparatus to rise to the surface.

About 1788 Smeaton substituted cast-iron for wood, which had been previously used, made the machine of rectangular form, increased its capacity, and employed a forcing-pump for supplying it with air. See DIVING-BELL.

Submarine armor was successfully used by Klingert of Breslau, in 1798. His diving-dress consisted of a metallic cylinder with a hemispherical top for covering the head, a metallic cyl-

inder and a leathern jacket for protecting the trunk, and leathern sleeves and drawers covering the arms to the elbows and the legs to the knees. The head-piece had glazed apertures enabling the diver to see beneath the water, and pipes for breathing supplied by an air-reservoir which was sunk with him.

Tonkin's apparatus, used in Britain at the commencement of the present century, was a suit of complete metallic armor, covering the whole body except the arms, and surrounded by an exterior dress of leather. Air was supplied by an elastic tube from a compressed air-vessel at the surface.

An apparatus exhibited by the New York Submarine Company at the Paris Exposition of 1867 consists of a strong helmet of metal cushioned on the interior, and having a plate-glass window in front, and a water-proof dress entirely enveloping the person. This is weighted sufficiently to sink and enable the diver to stand firmly on the bottom. An air-reservoir is fastened upon his back, containing a supply of compressed air sufficient for several hours; this is conducted to the interior of the dress by a pipe provided with a cut-off valve under the diver's control. A cock on top of the helmet permits the discharge of the foul air from time to time. In order to prevent the dress collapsing against the person at considerable depths, is an inside protector, formed of a series of rings or ribs surrounding the person and lower extremities. See ARMOR, SUBMARINE. See also SUBMARINE BLASTING.

Secured beneath the diver's arms are a pair of water-tight sacks, which may be inflated from the reservoir at his back when he desires to rise to the surface. See also RESPIRATOR, Fig. 4272, page 1923.

**Sub'ma-rine' Bat'ter-y.** (*Vessel.*) A vessel capable of being submerged and maintained at a given depth below the surface of the water, and provided with means for penetrating the hull of an enemy's ship below the water line or of blowing her up, — usually a torpedo arrangement, which may be detached from the battery and attached to the bottom of the ship. The first practical development of the idea appears to be due to Bushnell during the War of the Revolution. Fulton afterward made various experiments on the subject.

Rockets of large size, guided by a tube projecting from the vessel, have been tried, but without very flattering prospects of success. See SUBMARINE BOAT; SUBMARINE GUN; TORPEDO.

**Sub'ma-rine' Blast'ing.** (*Hydraulic Engineering.*) A means for the removal of submerged rocks, shoals, sunken vessels, or other impediments to navigation.

The first effort in this direction was probably that of Colonel Pasley, about 1841, in blowing up the wreck of the "Royal George," sunk at Spithead, England, in 1782.

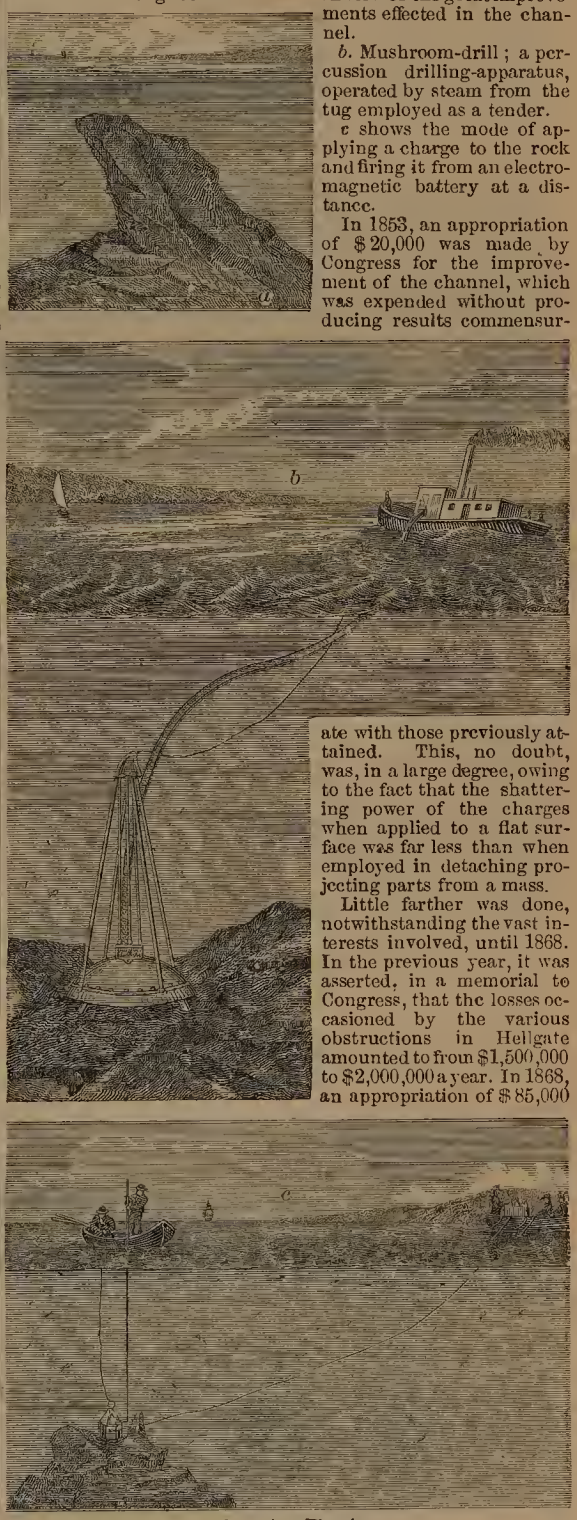
Fig. 6021 illustrates some of the operations for the removal of the submarine obstacles to navigation which formerly rendered that part of the East River known as Hellgate so dangerous to navigation in Long Island Sound. The principal of these were Pot Rock, on which the British frigate "Hussar" was wrecked at the close of the Revolutionary War, occasioning the loss of many lives and a large amount of treasure; Drake Rock; Holmes' Rock; the Frying Pan; and Way's Reef. These rocks were the cause of great injury to commerce, but though repeated surveys had been made and plans for their removal proposed, nothing was accomplished until the work was undertaken by Maillefert in 1851. Under an agreement with the New York Chamber of Commerce, this engineer undertook to remove Pot Rock, the Frying Pan, and Way's Reef for the sum of $15,000.

The first of these, shown in profile at *a*, was, at its highest part, but 8 feet below low-water level, and stretched across the strait, broadside to the current, for 130 feet, over which was an average depth of 10 feet water; the tide, setting through at the rate of 5 to 8 miles an hour, caused a fearful series of eddies and whirlpools among these rocks. At a short distance on either side, soundings of 50 to 75 feet are obtained. Owing to the strength and irregularities of the currents, boring was almost impossible, and the only time at which blasts could be effected was at slack water following flood or ebb tides.

M. Maillefert consequently applied his blasting charges, inclosed in water-proof cases, directly to the face of the rock, relying on the pressure of the body of water above to resist the expansion of the ignited powder sufficiently to cause it to shatter the stony stratum beneath.

The first blast was made August 19, 1851, and was perfectly successful, knocking off about 4 feet from the highest projecting pinnacle of Pot Rock. Operations were continued on this and other obstructions until March 26, 1852, when three men were killed by an explosion under the boat, owing to a misplacement of the battery connections. During this period 284 charges, containing in all 34,231 pounds of powder were exploded on Pot Rock, reducing its level to 18 feet below low-water mark; and 240 charges, containing nearly 27,926 pounds, on Way's Reef and the Frying Pan, by which they were considerably lowered. Shell Drake was increased in depth from 8 to 17 feet by the explosion of 6 charges of 125 pounds each upon it; and Bald-Headed Billy, a formidable isolated rock, dry at low water, was dislodged by a single blast, afterward drilled and split and the two parts grappled and removed. Two other small rocks were also destroyed. The total cost of these improvements was $13,000, a very small sum in view of the great improvements effected in the channel.

Fig. 6021.




*Submarine Blasting.*

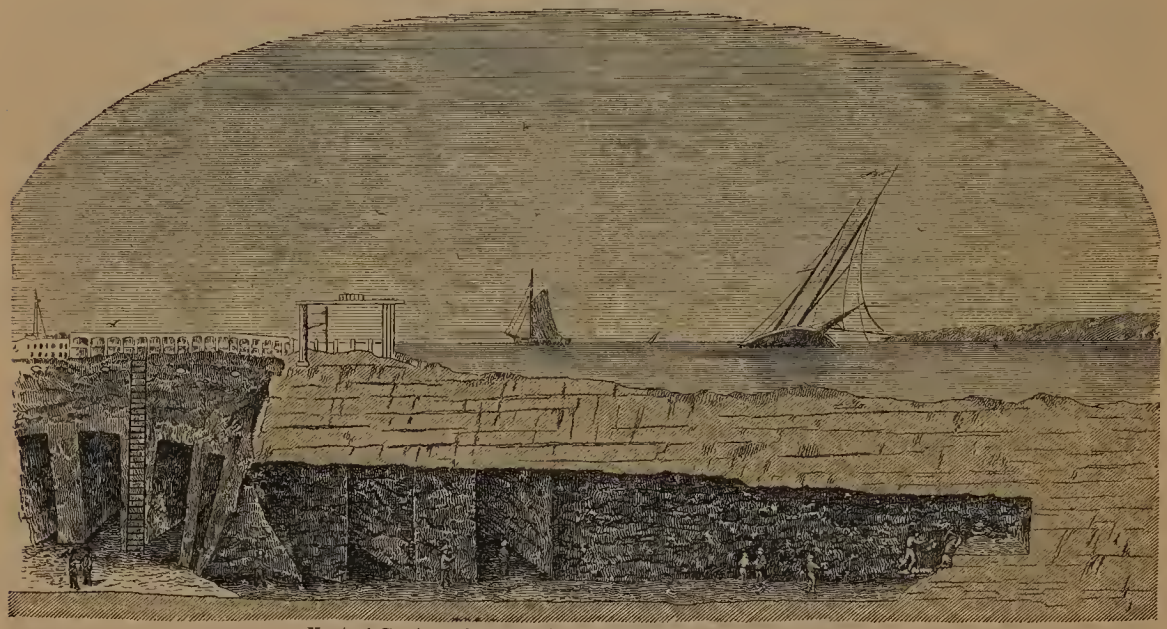
*b*. Mushroom-drill; a percussion drilling-apparatus, operated by steam from the tug employed as a tender.

*c* shows the mode of applying a charge to the rock and firing it from an electro-magnetic battery at a distance.

In 1853, an appropriation of $20,000 was made by Congress for the improvement of the channel, which was expended without producing results commensurate with those previously attained. This, no doubt, was, in a large degree, owing to the fact that the shattering power of the charges when applied to a flat surface was far less than when employed in detaching projecting parts from a mass.

Little farther was done, notwithstanding the vast interests involved, until 1868. In the previous year, it was asserted, in a memorial to Congress, that the losses occasioned by the various obstructions in Hellgate amounted to from $1,500,000 to $2,000,000 a year. In 1868, an appropriation of $85,000 was made for their removal. Proposals for undertaking the work varied from $38,000 to $500,000, showing, notwithstanding the elaborate surveys previously made, that the bidders were entirely ignorant of what amount of work the requirements to be fulfilled might ultimately necessitate.

Fig. 6022.

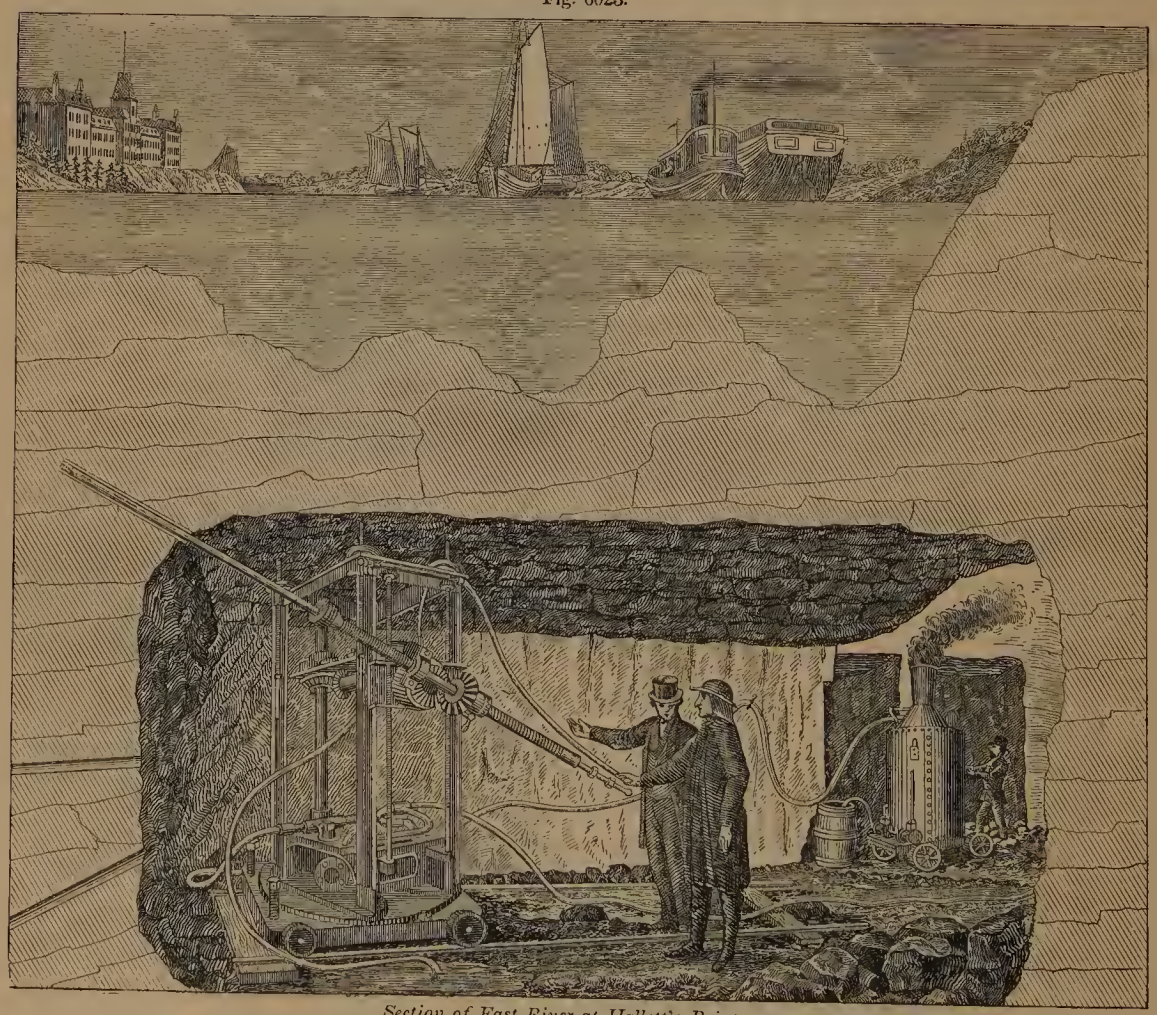


*Vertical Section of Excavation at Hallett's Point, New York.*

Mr. S. F. Shelburne of New York, being the lowest bidder, received the contract. He employed first a small diamond-drill, rotated by a turbine; but this proving ineffectual, a larger one, the "Mushroom," of similar construction, was substituted. Drills of this construction were, however, found inadequate to do the work in such an exposed locality; and finally a powerful striking-drill was employed with fair prospects of success, but was, however, unfortunately run down by vessels and destroyed before it was practicable to test its capabilities.

Plans had been suggested by the United States Engineer De-

Fig. 6023.



*Section of East River at Hallett's Point.*

partment, involving an outlay of from $3,000,000 to $9,000,000, to entirely remove all the obstructions, and ensure a depth of 26 to 24 feet at low water. The execution of these projects would have occupied from 4 to 10 years.

General Newton, United States Engineers, who had the general supervision of the work, in 1869, commenced operations by sinking a shaft beneath the ledge of rocks constituting Hallett's Point, which projects into the stream so as to throw the tidal current directly upon the Gridiron. For this purpose a coffer-dam 310 feet long, of heavy timbers bolted to the rock, and filled in with sand and clay, was constructed, the water pumped out, and a longitudinal shaft, having radial shafts extending from either side, excavated, the intention being to explode nitro-glycerine within the chambers, into which the displaced rock might fall and the fragments be afterward removed by grappling, if necessary.

Fig. 6021 shows a longitudinal section of "Grant" heading at Hellgate. The openings of other tunnels are seen to the left.

Fig. 6023 is a section of East River at Hallett's Point, and of one heading of the excavation, showing also the steam-drill. See also HEADING, Fig. 2463, page 1085.

The entire surface undermined measures 2¼ acres, and the cuttings aggregate 7,542 feet in length, varying in hight from 8 to 22 feet, and in width from 12 to 13 feet. There is a roof 10 feet thick between the mine and the water, and the latter, at the outer edge of the excavation, is 26 feet deep at low tide. Between the headings and galleries heavy piers are left, which now sustain the immense weight of rock and water above. In each pier from ten to fifteen 2 and 3 inch holes are being drilled, and in the roof similar apertures are being made at intervals of 5 feet apart. All of these openings will be filled with nitro-glycerine, in charges of 8 and 10 pounds, and all will be connected together by gas-pipe filled with the same explosive. This will be done during the cold weather, when the danger of hauling the nitro-glycerine is greatly diminished.

Fig. 6024.

*Effect of the Submarine Blast.*

Previous to the explosion, the coffer-dam will be broken away and the water allowed to fill the entire excavation, so that it will serve as a tamping. Then, by means of an electric fuse, the nitro-glycerine in the gas-pipe will be fired, which will determine the blowing up of the whole affair. No fear is apprehended as to the result, since it has been determined that the explosion of half the charges will be sufficient to cave in the roof, and cause it to fall to the sunken floor, deepening the water at once to a proper depth, or necessitating but little dredging to complete the work.

The entire roof is to be blown off on the 4th of July, 1876; we cannot delay the issue of this book for the purpose of recording the success.

The Diamond reef and Coenties reef have been removed by drilling and blasting. Divers, equipped with submarine armor, descend to adjust the drills, insert the cartridges, etc.

Fig. 6025.

*Diver Equipped for Descent.*

The new operations at Flood Point will involve still greater cuttings than at Hallett's Point.

Fig. 6024 illustrates the effect of a submarine blast as viewed from the shore or a passing vessel; and Fig. 6025 shows a diver equipped in complete armor just about to make a descent.

Fig. 6026 shows the diver at work.

Plate LXV. shows a view of the Hallett's Point operations, looking down into the shaft. The sails of ships appear above the coffer-dam, which holds back the water.

The Blossom rock, a dangerous reef lying directly in the course which vessels are frequently compelled to take in entering or leaving San Francisco Harbor, was discovered by Captain Beechey, of H. M. S. "Blossom," in 1826. It is situated nearly midway between the islands of Alcatraz and Yerba Buena, and its top was but 5 feet below mean low water previous to the operations which resulted in its removal as an impediment to navigation in 1870. It was composed of a metamorphic sandstone of variable hardness, having a specific gravity of 2.64, and in some places containing small beds of gravel cemented together with a bluish substance resembling clay. Its greatest length was 195 feet, and its greatest width 105 feet at 24 feet below low water. The quantity of rock to be removed in order to obtain this depth was 5,000 cubic yards.

It was proposed to effect its removal by excavating longitudinal and transverse chambers in the interior of the rock to a depth of about 30 feet below low-water mark, leaving a thick-

Fig. 6026.

*Diver at Work.*

ness of about 6 feet between the excavation and the bottom of the bay, with pillars of stone left between these chambers, as at *A*, Fig. 6027.

In order to sink a vertical shaft preparatory to excavating the horizontal galleries, a crib of timber, forming a coffer-dam having an interior open space 10 feet square, packed around with clay, was built and floated out to the reef, where it was sunk, and secured in position by driving steel-headed piles into the rock. On top of the crib a floor was laid, and a shed for lodging the workmen erected. The coffer-dam having been pumped dry and leakage stopped, a boiler-iron cylinder 6 feet in diameter was placed on it, and packing placed between it and the lining-walls. The sinking of the shaft was commenced December 7, 1869. At a depth of about 10 feet, the water again becoming inconvenient, a second iron cylinder of slightly less diameter was telescoped within the first; afterward a third cylinder of slightly less diameter than the second was similarly inserted.

When a depth of 30 feet was reached, drifts were run in the direction of the longer and shorter axes of the rock, and a swinging derrick constructed for hoisting the excavated matter by steam power and dumping it on the eastern slope of the rock.

The drifts were enlarged sufficiently to permit 16 men to work, who removed about 50 cubic yards of stone daily, and finally the chamber was increased to 140 feet in length, 60 in width, and 12 in hight, extreme dimensions. The crust of rock over the chambers was from 14 to 18 feet in thickness, or more than double that originally designed. This subsequently led to much labor in order to perform the conditions required.

The stone pillars were removed, with the exception of the four nearest the central shaft, and replaced by wooden props 8 to 10 inches square, each capped by a sill, between which and the surface of the rock wooden wedges were driven (*B*, Fig. 6027).

The arrangements were then made for blasting. For this purpose a nitrate of soda powder was used, being less expensive than ordinary gunpowder. Of this 43,000 pounds were used, placed in 38 ale-barrels and 7 old iron tanks, as shown at *C*, Fig. 6027. The charges were connected by tubes and wires.

An Abel cartridge was placed about midway of each iron tube and connected by two shorter wires with each of the battery circuit wires. The torpedoes were braced and fastened with timber, so that when water was admitted to the chamber, they would not rise to the surface. The charges were fired at 2 P. M., April 23, 1870, with a Beardslee battery, in a boat about 800 yards distant from the rock, raising a column of water 200

to 300 feet high, and 200 feet in diameter; around the base of this column was a simultaneous outburst of water probably about 70 feet high, which seemed to roll outwardly. The highest jet rose from the shaft.

An examination made shortly after the blast showed that there were but 14 feet water on the shoalest place over the rock. The fragments were removed into deeper water by a heavy iron drag, similar in appearance to an ordinary garden rake, and weighing $2\frac{1}{2}$ tons. This was suspended from a scow, which was towed back and forth over the rock by a steam-tug, which scraped the *débris* into deep water.

**Sub'ma-rine' Boat.** A vessel constructed to navigate beneath the surface of the water.

Drebbel of Holland constructed for James I. a vessel which was manned by 12 rowers, and was tried on the Thames. The effete air was again rendered respirable by a liquor whose composition was kept secret by the inventor. The Marquis of Worcester, in his "Century of Inventions," refers to a contrivance of somewhat similar import.

Robert Fulton published his work on this subject in New York, 1810. His experiments were made at Brest in 1801. On July 3, in that year, he embarked with three companions on board his plunging-boat in the harbor of Brest, and descended in it to the depth of 25 feet, which was about as deep as the strength of his machine would bear. He remained below in darkness one hour. He afterward tried candles, but objected to them as destroying the vitality of the air. Bull's-eyes were then inserted in the top of the boat, and found satisfactory. His boat had one mast, a mainsail, and a jib, which moved her at the rate of 2 miles an hour on the surface, and were stowed in 2 minutes when preparing to dive. When submerged, the vessel was moved by the exertion of 2 men at the engine, while he governed the position of the boat by regulating the machine which kept her balanced and determined her depth below the surface.

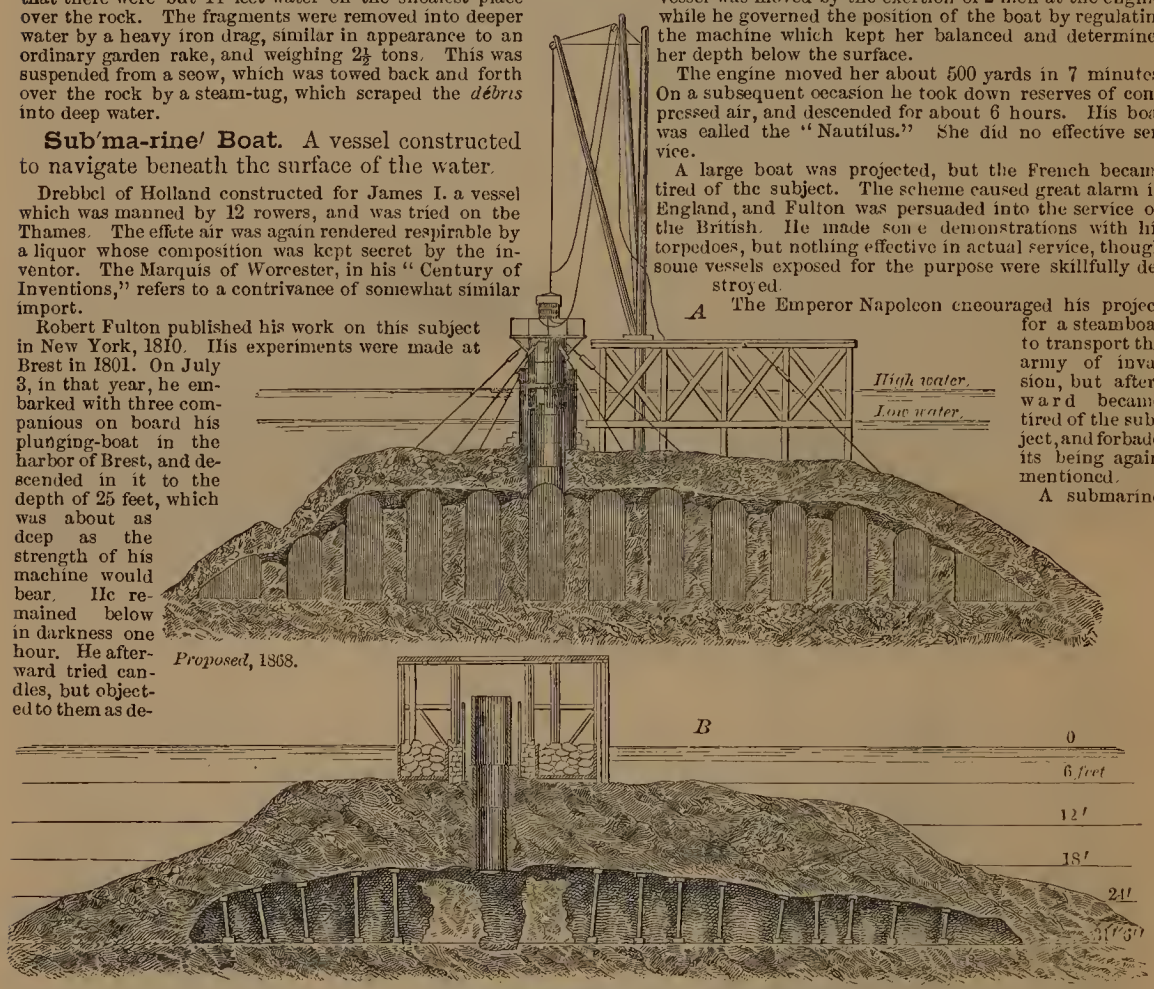
The engine moved her about 500 yards in 7 minutes. On a subsequent occasion he took down reserves of compressed air, and descended for about 6 hours. His boat was called the "Nautilus." She did no effective service.

A large boat was projected, but the French became tired of the subject. The scheme caused great alarm in England, and Fulton was persuaded into the service of the British. He made some demonstrations with his torpedoes, but nothing effective in actual service, though some vessels exposed for the purpose were skillfully destroyed.

The Emperor Napoleon encouraged his project for a steamboat to transport the army of invasion, but afterward became tired of the subject, and forbade its being again mentioned.

A submarine

Fig. 6027.




*Submarine Excavation and Blasting of Blossom Rock, Harbor of San Francisco.*

boat has been employed in the pearl-fishery by the Pacific Pearl Company. It is 36 feet long, 12 feet broad, and 13 feet deep, flat-bottomed, with two hatches in the bottom, through which the oysters are gathered. It is semi-spindle shaped on top, and has a turret for the entrance of the workmen; a compressed-air chamber; a working-chamber, into which the compressed air is admitted to expel the water when the bottom is reached; and a water or ballast chamber for sinking it. When it is desired to rise, the compressed air is let into this water-chamber, gradually expelling the water as the machine rises to the surface. The air in the chamber is compressed by a 30-horse-power engine to the density of 3 or 4 atmospheres.

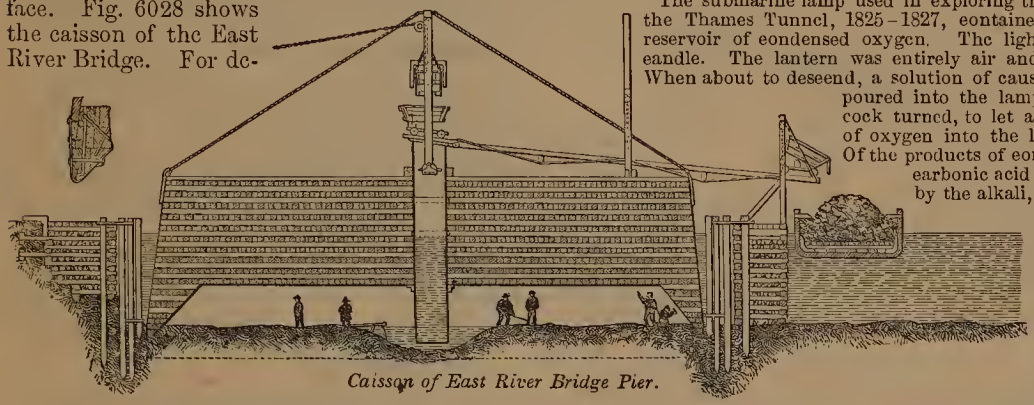
M. Denayrouze, whose subaqueous helmet and respirator are shown at Fig. 4272, has invented a submarine boat to move beneath the surface at 8 or 10 knots an hour, and carry a crew of divers to remove torpedoes and carry on blasting operations against submarine obstruction of even the hulls of enemies' vessels. The defense against such boats would be similar ones, and the transfer of the scene of combat from the surface to the depths would add an item of terror to what was already quite sufficiently desperate.

**Sub'ma-rine' Ca'ble.** (*Telegraphy.*) A wire, or combination of wires, protected by flexible non-conducting water-proof material, designed to rest upon the bottom of a body of water and serve as a conductor for the currents transmitted by an electro-

magnetic telegraphic apparatus. See TELEGRAPH-CABLE.

**Sub'ma-rine' Ex'ca-va'tor.** A device for removing earth or stone beneath the water surface. Fig. 6028 shows the caisson of the East River Bridge. For description, see the similar contrivance used in excavating for the piers of the St. Louis Bridge, page 49, and Plate II., opposite; also CAISSON, pages 420–422. See also DREDGING-MACHINE, pages 747–749; and other devices cited in the list under HYDRAULIC ENGINEERING, pages 1146–1148.

Fig. 6028.



*Caisson of East River Bridge Pier.*

Fig. 6029 shows an apparatus embodying a combination of conduits and mouth-pieces for excavating, dredging, and transmitting earthy and other loose matter, by means of forced currents of water, steam, or air, singly or combined. It is a form of dredge. The upper figures give details.

**Sub'ma-rine' Ex-plor'er.** A diving-bell or lantern (see SUBMARINE LAMP; SUBMARINE TELESCOPE) used in examining sites beneath the surface of the water.

Storm's submarine explorer (Fig. 6030) consists of an interior and exterior shell of wrought-iron, connected by braces *N*. The interior shell is divided by a horizontal floor into two compartments, the lower of which serves as a working-chamber. These communicate by the man-hole *Q*. The lower part of the space between the two compartments constitutes a water-chamber to regulate the flotative power of the apparatus, and is divided by vertical partitions *C C'*, to prevent the water from surging from side to side when the machine is being moved. An iron ring *E* is permanently attached to the lower part, to act as a sinker; and other rings *E'*, which may be made in segments, can be added, if necessary. Light is admitted to the upper chamber through conical tubes *F*, having lenses at their inner extremities, and falls upon reflectors *V*, which diffuse it through the chamber. The upper chamber is lined with sheet-zinc *R'*, having numerous V-shaped perforations, and backed with felting, to absorb the carbonic-acid gas produced by respiration. Suitable valves are provided for admitting and exhausting air and water as required. *O* is a man-hole by which the upper chamber is entered.

**Sub'ma-rine' Gun.** Submarine ordnance seems first to have been suggested by Saint Cyr in 1797, and consisted, as shown at *a*, Fig. 6031, of a mortar towed underneath a vessel by a span extending between two boats.

Fulton experimented with firing guns under water in New York Harbor in 1814, and was successful in penetrating a bulkhead representing the bottom of a first-class ship. His submarine battery of 100-pounder Colombiads is illustrated at *b* The gun traveled on its carriage, the barrel of the piece slipping in a packed port-hole. The port was closed by a shutter, which was raised by a lanyard, and dropped of its own accord when the gun recoiled.

Mr. Phillips of Indiana in 1855, and Woodbury of Boston in 1861–1864, worked at the problem. Woodbury's device is shown at Fig. 6032. An American submarine gun was shown at the French Exposition of 1867.

Fig. 6033 shows a submarine rifled projectile 5 feet long, 11 inches diameter, and with a bursting charge of 49 pounds. Total weight, 175 pounds.

**Sub'ma-rine' Lamp.** A lamp adapted to burn beneath the surface of the water.

The submarine lamp used in exploring the breaches in the Thames Tunnel, 1825–1827, contained a spherical reservoir of condensed oxygen. The light was a wax-candle. The lantern was entirely air and water tight. When about to descend, a solution of caustic alkali was poured into the lamp, and a stop-cock turned, to let a small stream of oxygen into the light-chamber. Of the products of combustion, the carbonic acid was absorbed by the alkali, and the water condensed on the sides of the glass. The oxygen mixed with the nitrogen to form atmospheric air.

Oil-lamps, constantly supplied with air by means of a forcing-pump, and the electric light, have also been employed. The first was objectionable on account of the trouble it occasioned, and the latter by reason of its expense and the strong shadows cast by it.

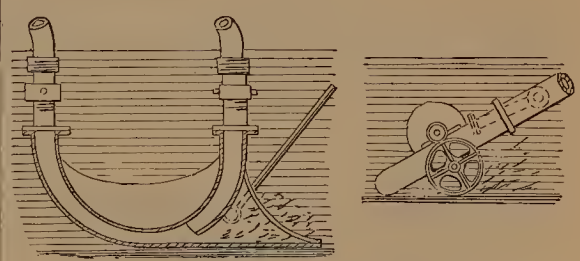
The lamp of MM. Leanté and Dénoyel is supplied with oxygen gas forced under a pressure of 10 atmospheres into a reservoir beneath, whence it is conveyed by a small tube to two annular receptacles, one inside and the other outside of the wick. Each is pierced with a number of small holes. Simple devices regulate the motion of the wick and control the supply of gas. The whole is protected by a thick glass cover, so as to be air and water tight.

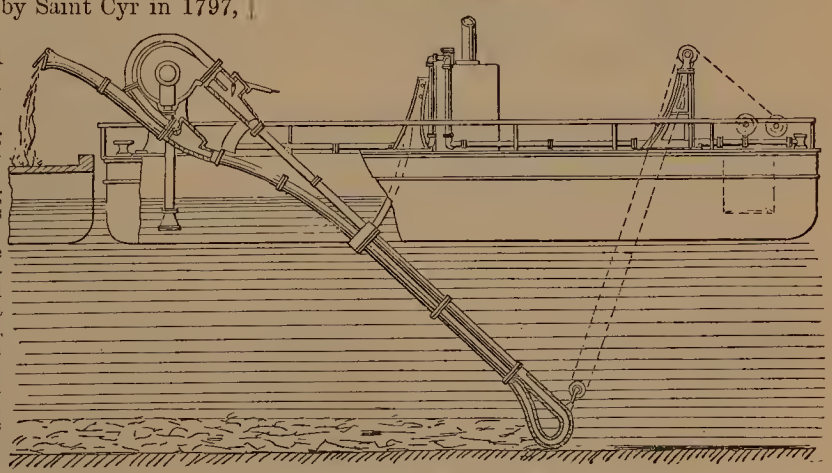
Van der Weyde's submarine lantern (Fig. 6034) has a cylindrical glass case, with the interior of which two channels communicate; one *C* connecting with a flexible pipe *D*, through which fresh air is injected, and the other *B* with the flexible pipe *E*, by which the products of combustion are carried off. *O* is the chamber, containing a hydrocarbon compound which readily vaporizes by heat, and *P* is the burner. The lantern is lowered by cords attached to the eyes *S S*. *T* is a ring by which the diver moves it from one place to another.

**Sub'ma-rine' Lan'tern.** See SUBMARINE LAMP.

**Sub'ma-rine' Pho-tog'ra-phy.** A photographic apparatus by Dr. Neumayer of Berlin, for ascertaining the temperature and direction of deep-sea currents.

Fig. 6029.

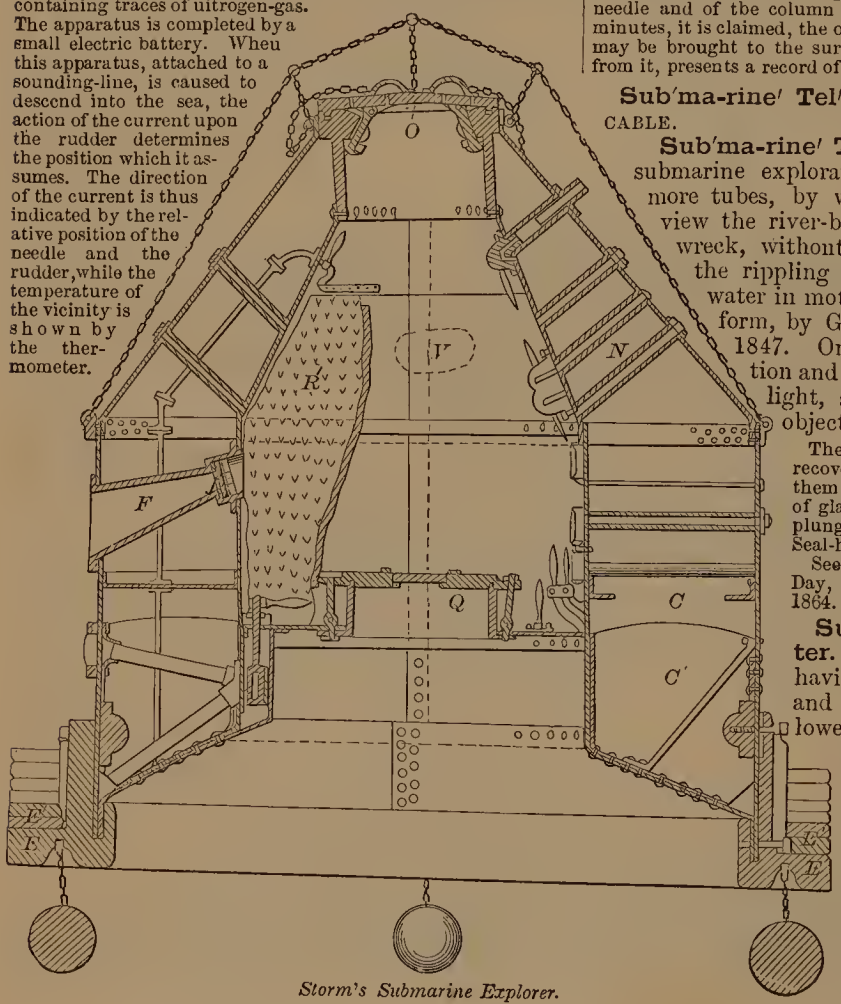




*Robertson's Excavating-Machine.*

It consists of a copper case hermetically closed, and furnished with an exterior appendage resembling a rudder. Within this case a thermometer and compass are inclosed, each in a glass vessel containing traces of uitrogen-gas. The apparatus is completed by a small electric battery. Wheu this apparatus, attached to a sounding-line, is caused to descend into the sea, the action of the current upon the rudder determines the position which it assumes. The direction of the current is thus indicated by the relative position of the needle and the rudder, while the temperature of the vicinity is shown by the thermometer.

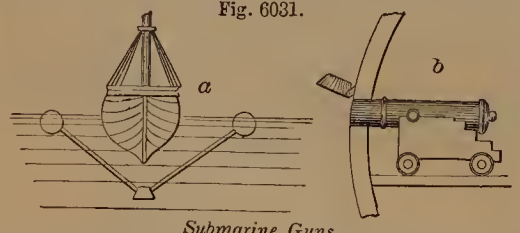
Fig. 6030.




*Storm's Submarine Explorer.*

But in order that these indications may be read at any desired spot in the ocean depths, it is necessary to fix them at the moment required. A leaf of photographic paper is placed in a

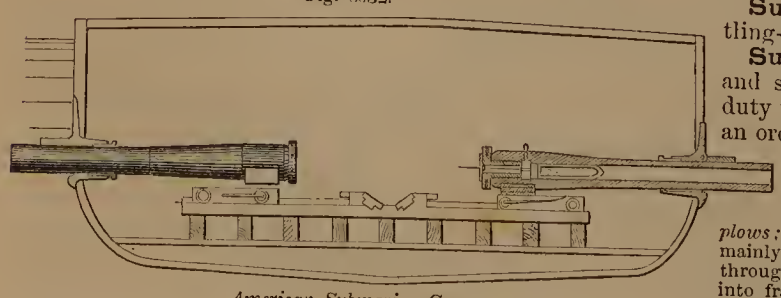
Fig. 6031.




*Submarine Guns.*

proper position next to the glass vessel containing the instruments. When it is desired to obtain the reading of the instruments, an electric current is sent through the nitrogeu gas contained in these vessels. This produces a very iutense violet light capable of acting chemically upon the photographic paper for a time sufficiently long to reproduce the shadows of the needle and of the column of mercury. At the end of three minutes, it is claimed, the operatiou is finished, the apparatus may be brought to the surface, and the paper, being removed from it, presents a record of the conditions observed in depth.

Fig. 6032.



*American Submarine Gun.*

**Sub'ma-rine' Tel'e-graph.** See TELEGRAPH-CABLE.

**Sub'ma-rine' Tel'e-scope.** A device for submarine explorations, consisting of one or more tubes, by which the eye is enabled to view the river-bed, an obstruction, rock, or wreck, without the distraction incident to the rippling and distorted refractions of water in motion. It was patented, in one form, by George Knight (England), in 1847. One tube was used for observation and the other for the direction of light, solar or artificial, upon the object.

The arrangement used by smugglers in recovering contraband articles sunk by them consisted of a cask having a plate of glass at the bottom. This end was plunged a few inches below the surface. Seal-hunters use the same contrivance.

See patents: Mather, April 16, 1845; Day, April 16, 1850; Mather, July 5, 1864.

**Sub'ma-rine' Ther-mom'e-ter.** (*Nautical.*) A chamber having valves above and below, and inclosing a thermometer, is lowered to the required depth, the water flowing upward through the chamber as it descends. When the descent is checked, the valves close, and the chamber is hauled up, containing water from the depth reached.

A registering-thermometer is now used. See THERMOMETER.

**Sub'ma-rine' Valve.** A port or valve in the side of a vessel, opening beneath the surface of the water, for the purpose of protruding a torpedo, the muzzle of a gun to be fired under water, or some other offensive weapon. See SUBMARINE GUN; TORPEDO.

In the example (Fig. 6035), the valve *D* is pivoted in a casing in the ship's side, being counected to the journal of the rock-shaft *F*, which may be operated from the engine-room or other convenient position. The movement of the valve is parallel to the side of the vessel, and covers or uncovers the exterior orifice of the blow-off pipe, a ventilator, or other opening. *i* is an index for showing the position of the valve.

**Sub'ma-rine' Ves'sel.** See SUBMARINE BOAT; TORPEDO.

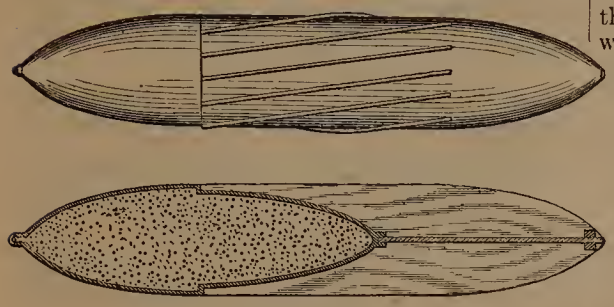
**Sub-merged' Pump.** A well or cistern pump which is placed under water, the pump-rod and discharging-pipe reaching from the surface of the ground to the pump.

**Sub-sid'ence-vat.** A dyer's settling-vat.

**Sub'soil-plow.** One having a share and standard, but no mold-board. Its duty is to follow in the furrow made by an ordinary plow, and loosen the soil to an additional depth without bringing it to the surface.

In England they are called *trenching-plows;* and sometimes *horse-picks*, from their mainly consisting of a sharp share which is forced through the subsoil, lifting it and breaking it into fragments. It is drawn by 4 horses, the wheelers hitched to the clevis, and the leaders

Fig. 6033.

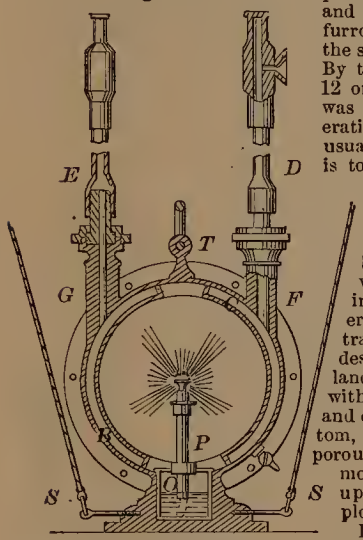


*Submarine Projectile.*

by a *soam*, or draft-chain, to the draft-rod of the plow, below the beam.

The first mention of subsoil-plows is in Worlidge's "Mysteries of Husbandry," 1677. He tells of an ingenious young man in Kent, England, who had two plows fastened on one stock, and the rear one plowing a furrow beneath the level of the sole of the preceding one. By this he stirred the land 12 or 14 inches deep. This was a regular subsoiling operation, though the now usual form of the implement is to stock the subsoil-plow separately and make it to follow in the wake of the ordinary plow.

Fig. 6034.



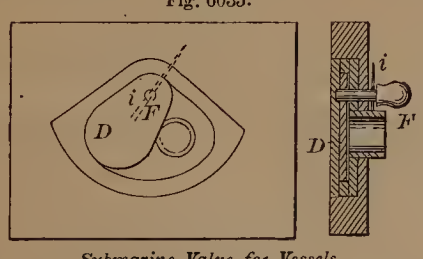

*Van der Weyde's Submarine Lamp.*

Smith of Deanston, Scotland, is credited with the invention and introduction of the modern implement. The illustration shows that it is destitute of mold-board and landside, having a share with wings adapted to raise and crumble the furrow bottom, comminuting it as a porous foundation for the mold which will be turned upon it by the ordinary plow in its next furrow. It has a curved colter, which is designed to be self-cleaning. The draft is applied by a draft-rod, secured by a *bridle* to the beam.

It is drawn by four horses, two and two, and managed by one man. The usual mode is to make a 10×6 inch furrow with an ordinary plow, and follow with the subsoiler at an additional depth of from 5 to 7 inches.

Stracey's subsoil-plow (English) has several points in common with its predecessor, as may be readily seen by comparison. It is used with a wheel, is higher in the throat, and has the broad, flat, sharp standard, which experience has indicated is the best form of sheth for the angle-iron or winged share which cleaves the subsoil.

Fig. 6035.




*Submarine Valve for Vessels.*

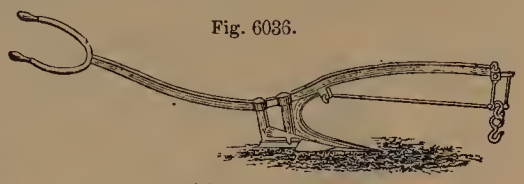
By a continued reduction of parts beneath the surface, the *subsoil-plow* becomes a *mole-plow*, in which a mere plug is attached to the *sheth* to force a way through the subsoil, leaving an arched drain, like a mole-track.

McMeekin's (Fig. 6038) has the standard *a* and brace *b* formed of a single bar of metal. The share has a flange which enters the loop thus formed, is bolted thereto, and is provided with a small landside and mold-board.

Fig. 6039 is an approved modern form of English subsoil-plow, adapted for subsoiling from 12 to 18 inches in depth. The plow-body is of wrought-iron. The small wheel serves as a furrow-marker.

**Sub'sti-tute.** An optional bar or section, as the *substitute sinker-bar*, a shorter section to be used when a full-length section is not suitable.

Fig. 6036.

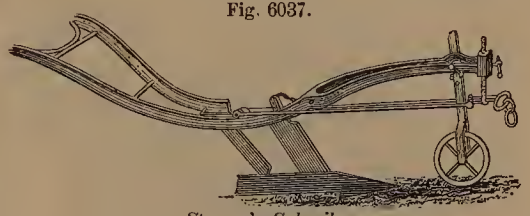


*Smith's Subsoil-Plow.*

Or a short section of sinker-rod having flanges to ream the hole and keep it straight. See WELL-BORING TOOLS.

**Sub'ter-ra'ne-an Rail'way.** A railway running its whole course beneath the level of the surface

Fig. 6037.

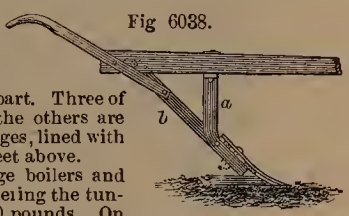


*Stracey's Subsoiler.*

of the ground. The occasional dipping beneath the surface is a tunnel.

The subterranean railway in London, between Victoria Street, Holborn, and Paddington, was constructed 1860–1862. It is 3½ miles in length, having stations at an average distance of ⅝ of a mile apart. Three of these have glass roofs; the others are lighted by slanting passages, lined with white tiles, from the street above.

Fig 6038.

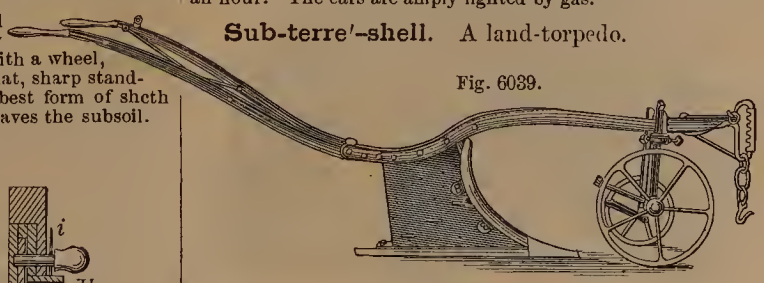



*McMeekin's Subsoiler.*

The engines have large boilers and cylinders, and before entering the tunnel steam is raised to 130 pounds. On entering the tunnel the exhaust is turned into a water-tank instead of up the chimney, so that the combustion of fuel is much reduced, and little smoke escapes; the steam-pressure is allowed to run down to 65 pounds, the cut-off being varied so as to maintain a uniform power sufficient to produce an average speed of 25 miles an hour. The cars are amply lighted by gas.

**Sub-terre'-shell.** A land-torpedo.

Fig. 6039.



*English Subsoil-Plow.*

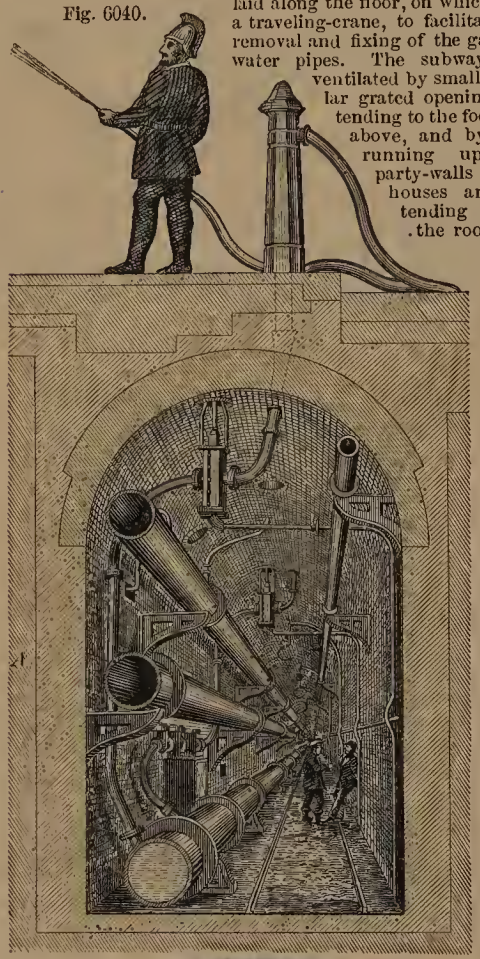
**Sub'way.** An underground tunnel beneath the street surface in which the gas and water pipes and sewers are lodged, so that they can be examined, repaired, replaced, etc., without disturbing the pavement.

The plan was proposed by Williams in London in 1822, and has been adopted in Paris. See SEWER.

In Fig. 6040, *A* represents one of the subways on each side of the Holborn Viaduct, London. These are 7 feet wide and 11 feet 6 inches high, running between the great arches which carry the roadway and the house-vaults which support each footway. They are located immediately above the sewers, are floored with stone, and lined with brick. Along the wall nearest the fronts of the houses is a 14-inch water-main, and above this two 10-inch gas-mains supported on brackets. On the opposite side is a pipe containing the telegraph-wires

Junctions are arranged for carrying water and gas into each house along the route by pipes conducted through holes in the sides of the subways. Branch pipes are laid on to the street fire-plugs and hydrants, and gas is laid on to the street-lamps. All the usual valves, meters, and other apparatus are accessible within the subway itself. Rails are laid along the floor, on which runs a traveling-crane, to facilitate the removal and fixing of the gas and water pipes. The subways are ventilated by small circular grated openings extending to the footways above, and by flues running up the party-walls of the houses and extending above the roofs.

Fig. 6040.



*London Subway.*

Where practicable, the entrance-doors are also constructed of open wire-work.

*B*, section of London subway; north side junction of Charterhouse Street.

*C*, section; south side at west end of viaduct.

**Suc'cu-la** A plain axis or cylinder, provided with staves or handles for turning it, but having no drum.

**Suck'er.** 1. A pump-bucket; *embolus.*

2. The leathern flap-valve of a pump-bucket.

3. A round piece of leather having a central perforation for the attachment of a string; when rendered flexible by wetting, and applied to a smooth object, as a stone, the adhesion between the two surfaces due to atmospheric pressure enables the lifting of the stone.

**Suck'er-rod.** A rod connecting the brake of a pump with the bucket.

**Suck'er-rod Swiv'el.** A swivcled link at the top of a pump-rod. See WELL-BORING TOOLS.

**Suck'ing-bot'tle.** An infant's feeding-bottle.

**Suck'ing-pump.** A pump in which the water is raised within reach of the bucket or plunger by atmospheric pressure. A *suction-pump.*

**Suck'ing-tube.** Most of us are acquainted with the taste of sweet cider as sucked through a rye-straw. They are used in many parts of the world for other liquids than cider. Besides their use among us with *cobblers* and *juleps*, the Peruvian drinks his or her *mate* by means of a tube with fine holes to keep back the particles of leaf. The sucking-tube was used by the ancients as a domestic utensil, and also in the temples. The latter use has also descended to our times in the *sanguisuchello*, or blood-sucker, a golden tube by which the Pope sucks up the wine at high mass. A *chalumeau*, or tube of gold, and silver "pypes," for the same purpose, are also mentioned in old inventories of church property.

Fig. 6041.

*Sanguisuchello.*

**Suc'tion-pipe.** That pipe of a fire-engine, or other pump, which conducts water from a cistern to the cylinder of a pump.

**Suc'tion-plate.** (*Dental.*) A dental plate retained in position in the mouth by atmospheric pressure.

**Suc'tion-pri'mer.** A small force-pump worked by hand and used in charging a main-pump.

**Suc'tion-pump.** A pump in which the plunger or bucket is placed above the level of the water, the latter rising by atmospheric pressure, as the *sucker* (bucket) is raised. Between the upward strokes of the bucket, a *clack-valve*, below the latter, falls and prevents the reflux of the water in the ascension tube. See LIFT-PUMP.

**Suc'tion-valve.** 1. The valve below the plunger or bucket of a pump, and which is lifted by atmospheric pressure acting upon the water beneath it, as the plunger is raised.

2. (*Steam-engine.*) The valve through which the water is drawn from the hot-well into the feed-pump by the rise of the plunger. See FEED-PUMP.

**Sug'ar.** A substance having a sweet taste, soluble in water, and capable of undergoing fermentation.

Three kinds are distinguished in chemistry: —

| | *Formula.* |
|---|---|
| Saccharine, or cane sugar | $C_{12}\ H_{11}\ O_{11}$ |
| Glucose, or grape-sugar | $C_{12}\ H_{14}\ O_{14}$ |
| Lactose, or milk-sugar | $C_{12}\ H_{12}\ O_{12}$ |

The first of these is derived principally from the sugar-cane (*Arundo saccharifera*), but is also obtained from beet-root, the sap of the sugar-maple, and various other plants. It is much sweeter and more readily crystallizable than either of the other kinds, and is that generally known to commerce.

The sugar-cane is a native of Asia. It is believed to have originated in China, and to have been used by the Celestials many centuries before it found its way to India and Arabia, from whence it was introduced into what is now the Christian world. In Sanscrit, sugar is *sarkara*. Our *candy* is also from the Sanscrit *kanda*. In Persian it is *schakar;* Hindostauee, *schukur;* Arabic, *sukkar*.

The references to it among ancient writers are few and indistinct. The first distinct notice of it is by Nearchus, who conducted the fleet of Alexander down the Indus. He speaks of the sugar-cane as growing in India, but does not refer to expression of the juice.

Sugar is mentioned by Dioscorides and Pliny, not from any commercial or domestic value that it possessed, but as a curious item of natural history and a presumed use as a medicine.

Galen also refers to it as a kind of honey secreted in reeds and brought from Arabia Felix and India.

It was known by the Greeks and Romans as an Oriental production, but was sometimes confounded by them with the *Tabaschir*, made from bamboo stems (Sauscrit; *trak-kschira*, bark-mill.) Moses of Chorene, who lived in the middle of the fifth century, was the first who described circumstantially the preparation of sugar from the juice of the *Saccharum officinarum* in the province of Khorasan.

It is also mentioned by Paul Eginetta, a physician, A. D. 625.

The Arabs seem to have introduced it wherever they went, finally into Sicily and Spain. Through them it became known to the Crusaders, who liked the sweet honeyed reeds, and one of their chroniclers describes the mode of expressing and purifying the juice as practiced by the inhabitants of Acre and Tripoli.

The cane was cultivated in Cyprus, 1148, and a grant from William II. of Sicily, in 1166, includes a sugar-mill with "all its rights, members, and appurtenances." It does not, however, appear to have been generally known in Europe prior to the middle of the thirteenth century.

It is said that a Venetian merchant in 1250 visited Bengal and informed himself of the mode of culture and preparation. The art of refining sugar and making sugar loaves was also communicated by a Venetian about 1550. It is not known whether he independently originated the idea, or whether he received it from China, where it had been practiced for ages. Boiling and baking sugar was first practiced in Europe about 1420.

Bartholomew was the first Englishman who described the method of crystallizing and purifying sugar.

The plant was taken by the Portuguese to Madeira in 1420, and soon afterward, in 1506, to the Canaries, from whence it was taken to Brazil and to St. Domingo. Its culture thence gradually spread throughout the West Indies. Barbadoes was supplied from Brazil in 1641, and the culture was introduced into Louisiana by French refugees from St. Domingo toward the close of the last century.

For notice of beet-root sugar, see *infra*, also page 255.

Maple sugar was first made by the Indians, and La Salle refers to it as a kind of manna.

*Sirup.* The *sirup* of commerce is the residual product obtained in refining raw sugar. This is dissolved in water, filtered and decolorized, boiled, and formed into loaves.

The sirup which drains out of the loaves, called *greens*, is again purified, decolorized, and boiled down to crystallization. The crystals are separated in the centrifugal machine, and sold as a very light-colored *coffee-sugar*. The *greens* from this sugar yield, by purification, decolorization, and boiling, a light yellow sugar. The last *greens*, after three successive crystallizations of sugar, are purified and sold as *golden sirup*. This sirup still contains a considerable quantity of crystallizable sugar, which cannot be profitably extracted, together with uncrystallizable sugar, coloring matter, and the substances which give to sirup its peculiar agreeable flavor, but whose exact nature is not known.

*Beet-Root Sugar.* Oliver de Serres, 1605, suggested the use of beets for making sugar. Margraff first produced sugar from beets in 1747; Achard, in 1799. Bonaparte encouraged it, as his connections with the West Indies were very precarious, and were likely to become more so. 60,000 tons of beet-root sugar are now produced annually in France. Large quantities are also made in Northern and Central Europe, forming a large proportion of the amount consumed. The industry has been introduced into Illinois and California. It prospers in the latter.

Napoleon devoted 80,000 acres and 1,000,000 francs to encourage this industry,—one which has since grown to be of much importance in Europe. It is computed that beet-roots now supply nearly a fourth of all the sugar furnished to the markets of the world.

The amount of sugar contained in the beet varies from 8 to 13 per cent. As high as 40 tons of beets per acre have been raised in some parts of France. This would give, at 10 per cent, 4 tons of sugar to the acre; an average of one fourth as much is, however, considered satisfactory.

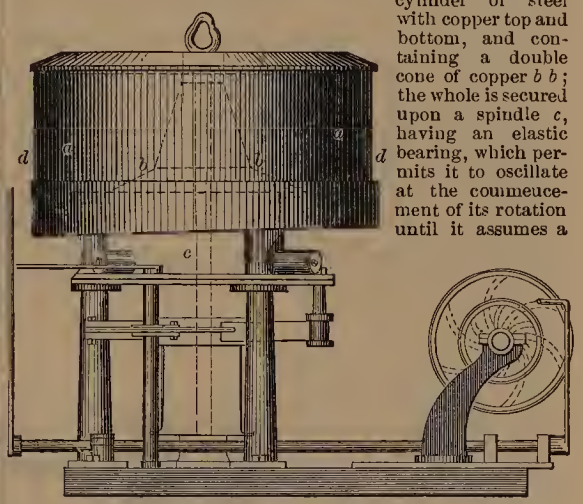
Beets for the manufacture of sugar are deprived of their tops, thoroughly washed by machinery, and then rasped into pulp or cut into thin shavings, according to the mode of manufacture practiced.

In the grating-machine the beets are fed into a hopper above and fall into two troughs beneath, where they are pushed forward, by means of two plungers operated by levers and links from a crank-shaft so as to have a quick return-motion, to a drum set with saws, which revolves at the rate of 600 to 800 revolutions per minute. The pulp is discharged into a chute.

In the slicing process a centrifugal root-cutter is employed. This consists of a stationary conical casing, within which are six grooved toothed knives. The beets fed from a hopper above are driven against the knives by two flyers on a rotary disk, and cut into slices of uniform thickness.

After the beets have been grated, the juice is expressed by a hydrostatic press, or by the centrifugal machine (Fig. 6042).

Fig. 6042.



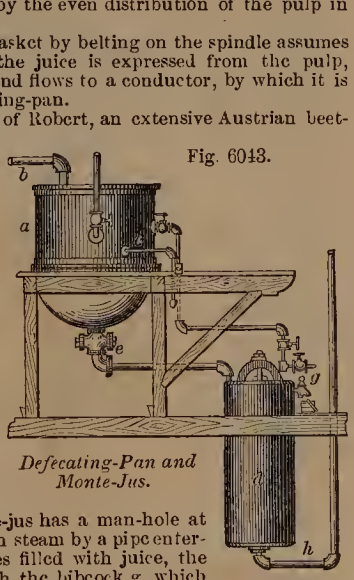

*Centrifugal Machine.*

The basket *a a* consists of a perforated cylinder of steel with copper top and bottom, and containing a double cone of copper *b b*; the whole is secured upon a spindle *c*, having an elastic bearing, which permits it to oscillate at the commencement of its rotation until it assumes a perpendicular position by the even distribution of the pulp in the basket.

The rotation of the basket by belting on the spindle assumes a great velocity, and the juice is expressed from the pulp, caught by the curb *d*, and flows to a conductor, by which it is conveyed to the defecating-pan.

The diffusion process of Robert, an extensive Austrian beet-root sugar manufacturer, is a mode of extracting the saccharine liquid from the pulp, and is described and illustrated, page 702, Fig. 1652.

Fig. 6043.




*Defecating-Pan and Monte-Jus.*

The defecating-pan *a* contains a steam-heated coil of copper pipe. The juice is admitted through the pipe *b*, while carbonic acid, entering through *c*, is distributed throughout the juice by a perforated pipe. The defecated juice and scums are drawn off into the *monte-jus d* through the cock *e*. The monte-jus has a man-hole at top, and is supplied with steam by a pipe entering above; as it becomes filled with juice, the air is driven out through the bibcock *g*, which also indicates when the monte-jus is full; when this takes place, the bibcock is closed and boiler-steam admitted, forcing the juice out through the pipe *h* into the receiving-tanks.

The filter-press is used for recovering the juice which runs off in the scums from the defecating-pan. Formerly the scums were put in bags and pressed in hydraulic presses. This required considerable manual labor and power, which is nearly all saved by the filter-press. This consists of a vat having cloth strainers, through which the juice is forced by steam-pressure. After this the sirup is passed through a *bone-black filter*, when it is ready for the evaporating-pans.

The sirup may be drawn off into another vacuum-pan for completion, or evaporated to the point of crystallization in the second evaporator, and then drawn off to crystallize, after which it is refined in the usual manner.

The refuse pulp from the manufacture of beet-sugar forms an excellent food for stock. Recent improvements are offered in

the treatment of the by-products of beet-root sugar-making. Hitherto they have been treated for the mineral salts they contain, and then abandoned. The residuary liquor is now concentrated, and by a process of dry distillation acetic acid, methyl, alcohol, and ammonia are obtained. The by-product is then treated for the mineral salts as before.

*Glucose.* *Glucose*, or *grape-sugar*, is a saccharine substance obtained from starch by boiling in water with one per cent of sulphuric acid. The liquid is drawn off, the acid neutralized by lime, precipitate allowed to subside, liquid decanted and evaporated.

Starch is also converted into a fermentable sugar resembling glucose, by the action of a diastase.

Ligneous fiber will also yield glucose by treatment with a stronger solution of acid than the above, the mixture being afterward diluted, boiled, neutralized by alkali, and decanted.

Glucose is also obtained from cane-sugar by boiling in diluted acid.

The term *glucose* has been made to comprise several distinct modifications of sugar, some of which are mentioned above, as well as the sugar of malt, cane sugar modified by acid; but, speaking in general terms, glucose is a non-crystallizable saccharine, which, like *dextrine*, turns the plane of polarization to the right hand, as the term *dextrine* indicates. Cane-sugar (*sucrose*), on the other hand, is crystallizable, and turns the plane of polarization to the left. See Miller's "Elements of Chemistry," Part III. pages 71, *et seq.*

Glucose is developed in the process of malting, and its infusion is the solution called *wort*, from which *beer* is made; or it makes the *wash* of the distiller.

Among the processes for the expedition or more perfect performance of the change of condition may be cited: —

Riley, March 5, 1850, converts corn meal into glucose under pressure in a boiling solution of sulphuric acid: water, 1,000 gallons; acid, 25 pounds.

Reitsch, February 3, 1852. The saccharine matter of wort evaporated to a viscid mass.

Hoffman, May 25, 1858. Meal treated with dilute sulphuric acid and steam under pressure of 350° Fah. Decant and evaporate.

Hawkes, February 3, 1863. Wort of malt boiled with decoction of hops; cane-sugar added; boiled to a thick sirup; add gelatine, and can.

Weiderfeld, April 28, 1863. Meal steeped in water impregnated with gases resulting from dry distillation of sulphuric acid; wood charcoal; crystallized soda.

Goessling, May 10, 1864. Corn soaked, bruised between rollers; soaked in repeated waters, to prevent fermentation. Knead, pass through sieve, wash; treat with caustic potash, then with acid and steam; neutralize with alkali; steam, fine, filter, and concentrate.

Thompson, June 7, 1864. Macerate grain in dilute acid.

Fleischman, July 12, 1864. Macerate grain in sulphurous-acid gas water. January 5, 1865. Add bicarbonate of soda to above, developing hyposulphurous acid.

Goessling, December 20, 1864. Attempts to crystallize a mixture of corn or starch sirup and cane-sugar.

Percy, February 28, 1865. Whey of milk and albumen boiled, and the resulting lactine treated with sulphuric acid or malt to produce glucose.

Hawks, June 27, 1865. Ground malt is macerated with corn meal and elutriated to remove saccharine, which is evaporated *in vacuo*.

Goessling, September 5, 1865. Soak corn in alkaline ley. Crush, strain, and add the starch to a boiling acid solution, defecate with charcoal, neutralize with alkali. Evaporate and crystallize (?).

Goessling, September 5, 1865. Two modifications of the last.

Watson, December 5, 1865. Kiln-dry meal, and macerate in water.

Seely, January 10, 1865. Saw-dust purified by alkali, macerated in boiling acid solution, and added to 5 times its quantity of starch, and 10 times the quantity of water. Concentrate.

Deissner, June 19, 1866. Corn boiled in water; malt, sugar, and flour added.

Hirsh, October 16, 1866. Corn soaked in dilute sulphuric-acid; heated to 170° Fah.; ground, sieved, washed; starch boiled in solution of sulphuric acid, sulphuric alumina, and charcoal. Neutralize, concentrate, evaporate, defecate with bone-black, filter, concentrate *in vacuo*.

Hoff, December 18, 1866. Soak barley in fennel water, and malt it; add various fragrant herbs. Ferment.

Pigeon, April 23, 1867. Starch and cellulose treated in acidulous water, boiled under pressure. Saccharine liquid neutralized with lime, filter, defecate with bone-black, concentrate to 20° B. Allow the lime to precipitate. Filter; neutralize with soda. Boil, crystallize (?). Mold.

Loew, June 25, 1868. Woody fiber digested in hydrochloric acid, and heat; acid distilled over. Glucose and paper-stock the results.

Wesselholft, October 6, 1868. Extract of malt for dietetic purposes.

Sim and Hutchinson, March 16, 1869. Meal treated with bisulphide of carbon to extract oil, rendering starch more easily saccharified.

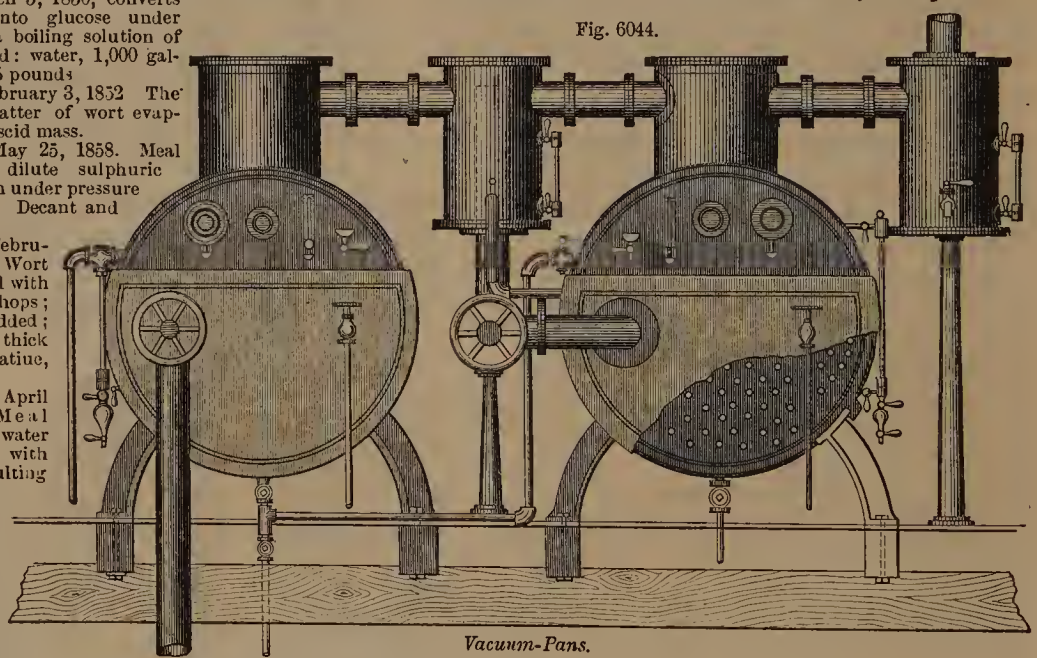
Delamarre, December 6, 1870. Sweet potatoes steamed, mashed, and mixed with malt, macerated, steamed, pulp precipitated, saccharine liquid decanted, concentrated.

Grosheintz, May 23, 1871. Hydrochloride or sulphuric acid saturated with an alkali to produce a salt which may remain in the saccharine matter.

**Sug'ar-cane Mill.** A mill for grinding sugar-cane. See Figs. 1059 – 1061, page 444. See also SUGAR-MILL.

**Sug'ar-cane Plant'er.** A machine for planting ratoons of cane in furrows made by the plow, to afford sprouts for the future plant.

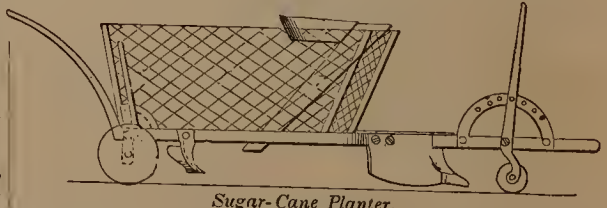
Fig. 6044.



*Vacuum-Pans.*

In Fig 6045, the cane-slips are placed in the chute and delivered into the furrow made by the first plow; the two side-plows cover the cane, and the scraping-plates level the ground. The body is vertically adjustable by lever-arms carrying the wheels.

Fig. 6045.



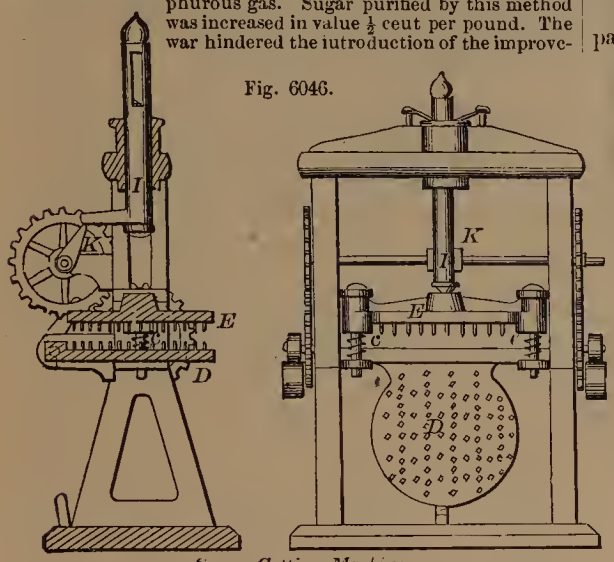
*Sugar-Cane Planter.*

**Sug'ar-clar'i-fi'er.** A filter for removing mechanical impurities or feculences from sirup. See

SUGAR-DRAINER ; CENTRIFUGAL FILTER ; etc. Or a DEFECATOR, see Fig. 1605, page 683 ; or other process by which immature, non-crystallizable, or fermenting matter is removed from sirup.

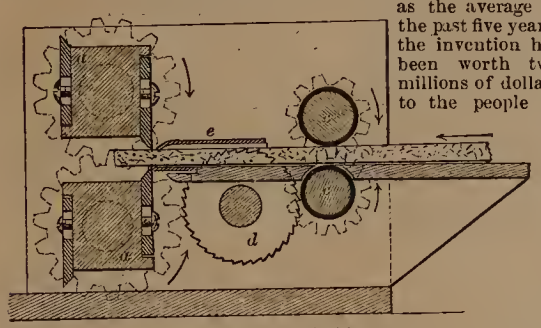
"In 1859, Richard H. Stewart patented a process of clarifying cane-juice for the manufacture of sugar, treating it with sulphurous gas. Sugar purified by this method was increased in value ½ cent per pound. The war hindered the introduction of the improvement, but since 1867 it would be difficult to find a planter who has not adopted it. In 1860, the sugar crop of Louisiana was 500,000 hogsheads. In 1867, it was only 5,000. In 1872, it had reached 80,000. If we take this figure as the average of the past five years, the invention has been worth two millions of dollars to the people of the United States during that period. Stewart received, from the fourteen years of his original patent, $44,350 ; or, in other words, he made from his patent in fourteen years not quite as much as the country made from it in six weeks. When the sugar production of Louisiana shall have reached its former extent, this improvement will add two millions and a half of dollars annually to the wealth produced by that State." — WHITNEY.

Fig. 6046.



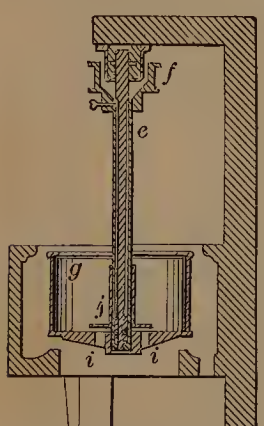

*Sugar-Cutting Machine.*

Fig. 6047.




*Cube Sugar-Machine.*

Fig 6048.




*Centrifugal Machine.*

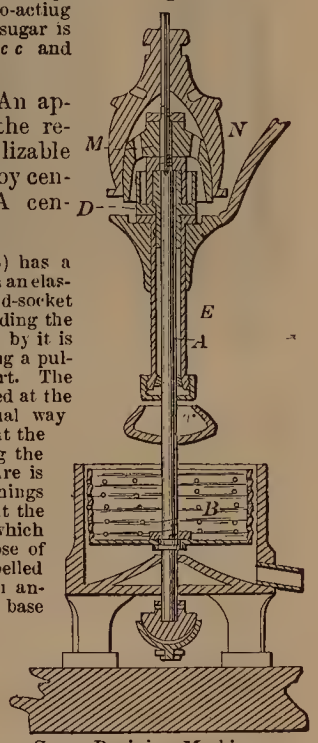
**Sug'ar-cut'ting Ma-chine'.** A machine for cutting up loaf or hard sugar into lumps.

In the example (Fig. 6046), the sugar in flat cakes is inserted between the hinged table *D* and the reciprocating-table *E*, both of which are studded with quadrangular pins. The table *E* is swung up and down by a cam-movement; the table *E* is struck by a hammer *I*, lifted by means of the wiper *K*, and is immediately after the impact thrown up by springs *c c*.

Fig. 6047 is a machine to cut loaf-sugar into cubes, operating upon slabs which are either molded in that form or sawn from the loaf.

The slab of sugar is laid upon the bench and pushed over the gang of parallel vertical saws *d* (only one of which shows in the elevation), which cut it into slips; passing onward, these slips are cut into cubes by the co-acting revolving cutters *a a*. The sugar is held by pressure-rollers *c c* and spring-clamps *e*.

Fig. 6049.




*Sugar-Draining Machine.*

**Sug'ar-drain'er.** An apparatus for separating the residual, non-crystallizable matter from sugar by centrifugal action. A centrifugal machine.

Weston's (Fig. 6048) has a spindle suspended from an elastic bearing or a ball-and-socket joint above. Surrounding the spindle and supported by it is a hollow shaft *e* having a pulley *f* at its upper part. The cylinder *g* is perforated at the periphery in the usual way and has openings *i i* at the bottom for discharging the sugar after the moisture is expelled. These openings are closed by a plate at the bottom of a sleeve *j*, which is lifted for the purpose of discharging. The expelled molasses flows into an annular trough in the base of the exterior casing, and access to the bottom of the cylinder is entirely unobstructed. The yielding bearing at the top of the spindle permits it to assume a truly vertical position when the cylinder is charged, and prevents any tendency to irregularity of motion when revolving.

In ordinary machines of this class the sugar is discharged at the top. In the English patents of Hardman, October 5, 1843, and Alliott, February 3, 1851, it was proposed to effect the discharge at the bottom. In the former, a circular plate below the cylinder was employed for closing the discharge-openings; this was lowered a certain distance for the purpose, still, however, remaining in the way. In the latter, the cylinder had to be turned, so as to bring an opening in its bottom directly over a funnel through which the discharge was effected. In both, the bearings of the shaft were under the cylinder, and obstructed the free delivery of the sugar.

**Sug'ar-drain'ing Ma-chine'.**

In Lafferty's centrifugal machine (Fig. 6049), the filter-box *B* is of corrugated metal, surrounded by woven wire. The shaft *A* is driven by a compound pulley composed of a drum *N*, which receives the belt, and an interior conical part *M* fitting within the former, and having perforations which cause a circulation of air around the shaft to cool it when in rapid motion. The oil from the cup *D* passing down the shaft flows down between it and the hollow exterior casing *E*, and is finally received in the drip cup *T*, which is so shaped as to prevent the oil being thrown out by centrifugal action. By lifting the barrel *N* it is disconnected from the cone *M*, and the rotation of the shaft is stopped. The appurtenances of the shaft are sustained by a hanger.

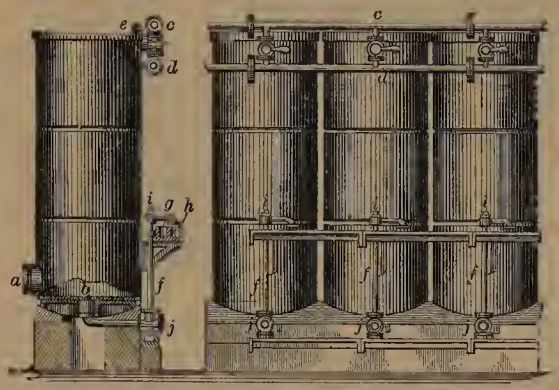
See also CENTRIFUGAL FILTER, Figs. 1213, 1214, page 514.

**Sug'ar-e-vap'o-rat'or.** A furnace and pan for condensing saccharine juices or solutions. See EVAPORATOR, pages 811 – 813.

**Sug'ar-fil'ter.** (*Sugar-making.*) The vessel employed for cleansing and decolorizing the defecated sirup by the aid of bone-black.

Those commonly employed are about 10 feet high by 4 feet in diameter, and open at the top; three are shown in the illustration. Near the bottom is a man-hole *a*, and below this an iron grating *b*, upon which a piece of filter-cloth is laid, and the vessel then filled with charcoal to within about a foot of the top. Sirup is then admitted through the pipe *c* until the charcoal has absorbed nearly all the coloring matter which it is capable of doing. The supply of sirup is then shut off, and cane-juice from the defecators is let on through the pipe *d* expelling the sirup; the power of the charcoal having been previously exhausted, its action upon the juice is simply mechanical. When this has continued to flow some time, it is shut off, and pure water is let in from the pipe *e*. This, in turn, drives out the cane-juice, and is allowed to flow until it no longer extracts

Fig. 6050.



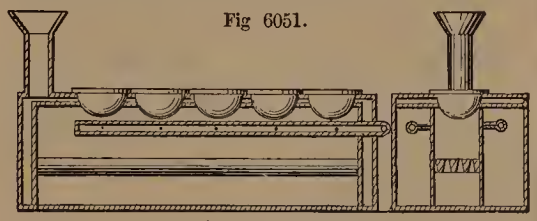

*Sugar-Filtering Apparatus.*

sufficient saccharine matter to pay for concentration. Several filters are employed, so that while one is filtering sirup, the second may be filtering cane-juice, and the third be cleansed by water.

The liquor and juice are drawn off by the pipe *f*, which discharges into the gutters *g h* through the swivel-joints *i*. The water is discharged through the cock *j* into the gutter below.

See also BAG-FILTER, Fig 522; CENTRIFUGAL FILTER, Figs. 1213, 1214. See also BONE-BLACK, pages 327, 328.

Fig 6051.



*Sugar-Furnace.*

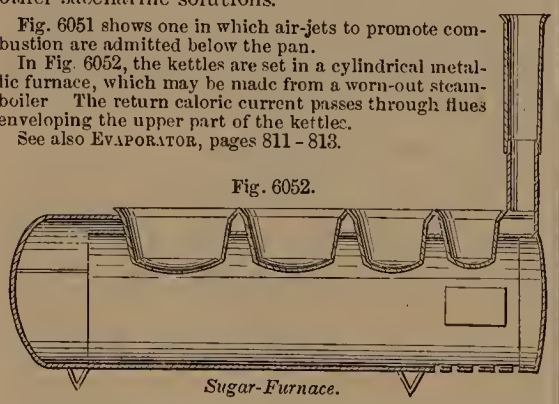
**Sug'ar-fur'nace.** One in which pans are set for boiling sugar-cane juice, the sap of the maple, or other saccharine solutions.

Fig. 6051 shows one in which air-jets to promote combustion are admitted below the pan.

In Fig. 6052, the kettles are set in a cylindrical metallic furnace, which may be made from a worn-out steam-boiler The return caloric current passes through flues enveloping the upper part of the kettlec.

See also EVAPORATOR, pages 811 - 813.

Fig. 6052.



*Sugar-Furnace.*

**Sug'ar-gran'u-lat'or.** Hersey's sugar-dryer is for granulating damp sugar.

The sugar is fed into one end through a spout, by a set of rolls placed above the machine, and by lifting shelves on the inside of the outer cylinder is carried up and dropped in a continuous shower upon the heating cylinder, and rolls off by the rotation of the machine, to be again carried up, working forward to the opposite end by the inclination of the apparatus, and is there delivered into the screen for separating into the different grades.

The steel plate heater-cylinder is put centrally within the iron conveyor-cylinder, which is 23 feet long and 6 feet in diameter, the heater-cylinder being 20 feet long and 33 inches in diameter, and makes five revolutions per minute. A striker passes off any sugar that may adhere to the cylinder when first entering the machine, and is operated by cams. The machine is rotated by means of outside gear on the conveyor-cylinder.

The current of air constantly passing through the machine carries off the moisture from the sugar through a pipe. The sugar is delivered cool from the end into which the cold air is passing, so that it does not cake, and can be immediately barreled, and will not cause the barrels to shrink.

**Sug'ar-ket'tle.** A kettle for boiling the sap of the sugar-maple (*Acer saccharium*), the sorghum, or the cane. A *sugar-pan*. See EVAPORATOR.

**Sug'ar-ket'tle Bat'ter-y.** A range of kettles in a sugar-furnace. See SUGAR-FURNACE.

**Sug'ar-ma-chin'er-y.** The old system of boiling in open pans is still in operation in cane-producing countries. The cane, on being passed through the rollers of the grinding-mill, is deprived of its juice, and the stalk or *bagasse* is carried on an endless belt to fall into a cart below, to be spread in the fields to dry, to form fuel for the furnaces. Meanwhile the juice runs through strainers, and is lifted by a force-pump to oblong troughs, which stand near the chimneys of the furnace. In these it is allowed to settle, and the scum rises in a few minutes to the surface, a gentle heat being applied. The juice is then drawn off into a train of copper kettles below, to be converted into sugar.

In the first of these kettles it is treated to a little milk of lime, which causes the scum to rise in a body to the surface, when it is removed by a skimmer. From this pan it is advanced to others, according to its advance toward crystallization, nearer and nearer to the mouth of the furnace, boiling furiously until it reaches at last the pan called the *teache-pan*, or *strike-pan*, over the mouth of the furnace. As the entire contents of one pan is discharged into the next, at the same time that a fresh supply of juice is introduced from those behind it, all are kept full, and the process of dipping is a very lively one, when the fires are well kept up. The feculences are principally skimmed off in the rear pan, in which the crude juice is introduced, but they are also skimmed off the boiling liquid in the other pans as they arise.

In the last pan the ultimate condensation is reached, and the sirup is subjected to the *teache* or touch test, by which its condition is determined. This is a delicate test, requiring judgment, but is preferred to the saccharometer, where the "sugar-master" is skillful. The test in making maple-sugar is different, as it is made in water, the condition of the *wax*, when rapidly cooled, indicating whether it is ready to take off or not.

From the *strike-pan* the sugar is run into shallow coolers (see COOLER), where it remains for about 24 hours, and is then transferred to cones or hogsheads to drain off the molasses. The hogsheads are set in a room called the *purgery*, resting on beams, and the molasses draining into a cistern beneath. (See PURGERY.) The cones are set into racks, and, after an interval of a couple of days, are removed to the *purgery*, the plug at the apex of the cone being removed as may be necessary to allow the non-crystallized portion to drain off. In about 20 days the loaf of sugar is found to be hard; white at the base, darker in the middle, and yellow, with molasses at the top, which, when dried, forms three grades in the Havana market. See EVAPORATOR.

The following are the processes: —

*Grinding.* The cane is first crushed by a powerful mill, driven by an engine of 60 horse-power, and having 3 rollers 8 feet in length and 3 feet in diameter. The cane is supplied by an endless belt moving in a channel-way of the same width as the rollers, and running almost level with the ground for 50 or 60 feet. 30 or 40 women are constantly employed in supplying this feeder with cane-stalks, which are smoothed by others. The stalks pass unceasingly between the rollers, the crushed cane falling upon another endless belt, which carries it out of the mill and drops it into light carts, which carry it to the fields to dry. This duty requires 7 carts. The cane is brought by trains of cars on a tramway from the field. See CANE MILL.

*Straining.* The juice runs in a heavy stream from the mill, and passes through coarse strainers, which intercept dirt and pieces of cane. It is then pumped into cisterns in the boiling-house, from whence it is drawn in the defecators.

*Defecating.* These are copper kettles with steam-jackets, and

at the Yngenio San Martin there are 16 in a row. The juice being turned into one until it is nearly full, the stopcock is closed and that of the next opened. Steam is then admitted to the jacket around the first, a little slaked lime is added, and it is raised to the boiling-point. Being allowed to simmer a few minutes, a thick scum rises, and the consistence of the latter determines the time to draw off. The defecator discharges by a pipe beneath it, the clear juice running into a trough; as soon as it begins to run dirty with the broken scum, the stream is turned into another trough, leading it to a receptacle whence it is withdrawn to be purified again. A jet of cold water cleans the defecator, and it is again ready for duty. The same is true of each defecator, and when properly proportioned in size and number to the other machinery, they are worked in a regular succession, the first being again ready for duty as the last is charged, and the juice from the mill being kept constantly running. In the San Martin the circuit is completed in about an hour.

*Filtering.* The hot stream of defecated juice is poured into charcoal filters, 10 feet high, 23 of which stand in a row, dividing the defecators from the hulk of the machinery; and behind them is another rank of 20 filters, as many feet in hight, in which the juice is finally purified. The filters are charged with animal charcoal, and hold an amount valued at $2,000. A charge lasts about 7 days, and is then replaced by fresh bone-black, the sticky and lusterless coal from the filters being taken to the washing-machines, and thence to the furnaces to be re-burnt. This is repeated until the coal becomes too fine for use, the loss being about 10 per cent at each use. See page 328.

It may be mentioned at this point that processes for defecating by the use of sulphurous gas have been used, and apparatus for this purpose patented. The object is to bring the juice in contact with the gas, which removes the tendency to fermentation, and thus prevents the disorganization of the sugar, by which it is turned to grape-sugar, increasing the yield of molasses and decreasing that of crystallizable sugar.

*Condensing.* After passing through the smaller filters, the juice is carried to the condensers, which perform the double duty of condensing the vapors rising in the vacuum-pan, and of evaporating the cane-juice which flows over them. These condensers constitute the distinguishing feature of the Degrand (Derosne) train, and are largely employed on some estates. A condenser is formed of horizontal pipes about 6 inches in diameter, arranged in a tall rack and formed by a convolution of the pipe, so that while the vapor from the vacuum-pan passes back and forth downwardly on the inside, the juice from the filters drips on to the upper fold of the pipe, and from thence to the next below, so as to keep the outside of the whole series wet, parting with a portion of its moisture, which rises in clouds of steam to the roof of the building.

Objections have arisen to the use of the Degrand condenser from the difficulty of keeping the pipes covered with an even film of juice, and the presence of clouds of steam which become condensed again in the building and interfere with other operations; the crystallization of the sugar, for instance. In some establishments the Degrand condenser is merely used to obtain the vacuum in the pan, water being dripped upon it instead of sirup. See CONDENSER, Fig. 1421.

*Boiling.* After passing the condensers, the sirup passes to the first vacuum-pans. In them the sirup is farther condensed, but not to the stage of granulation, it being subjected to a farther clarifying process before the final boiling. The vacuum-pan consists of a closed vessel with means for withdrawing the vapor as it is generated, and lowering the pressure of the atmosphere upon the sirup, so that the latter will boil at a lower temperature. This is favorable to the color of the sugar, as it is not subjected to a burning heat, and is also protected from the action of the atmosphere. It should have been mentioned that all the heating operations, in the defecators and in the vacuum-pans, are by means of steam under pressure. The vacuum-pans differ in some respects in their construction, though possessing the peculiar characteristic cited. They are spheroidal or nearly so, or cylindrical; are generally heated by jacket and internal coil, and are furnished with pipes and stop-cocks, by which the sirup and steam are supplied to their respective places, the water of condensation removed, the condensed sirup discharged, etc. See VACUUM-PAN.

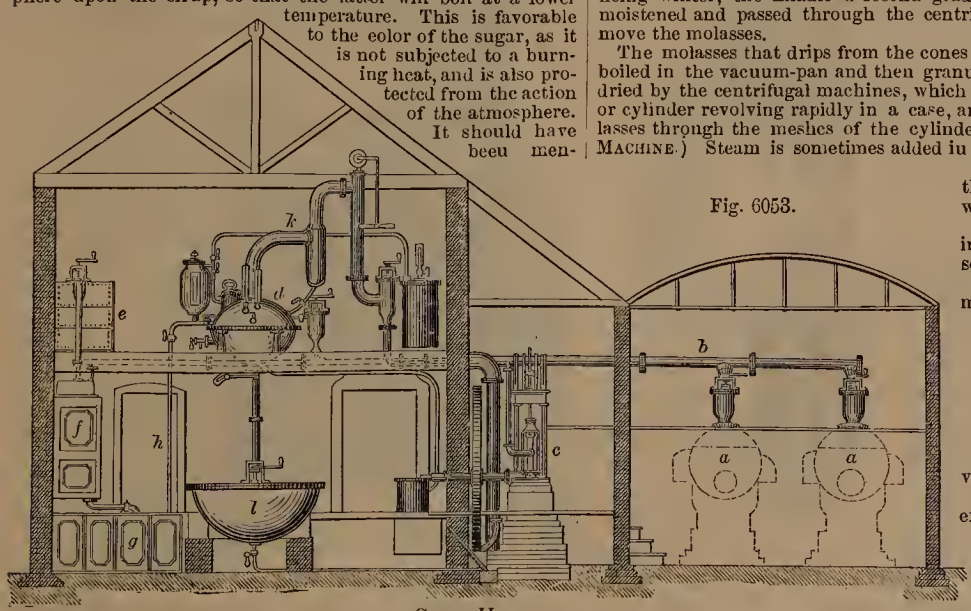



Fig. 6053.

*Sugar-House.*

The usual form of Derosne's vacuum-train is what is called the double effect; that is, two pans stand side by side, one of which is boiled by the steam rising from the sirup in the other, the sirup also being drawn at intervals from the first to the second. In the San Martin they possess two trains of three pans each, the middle pan being slightly the largest and discharging its steam into both the others. In some places a treble effect has been tried, the vapor from the first pan boiling the sirup in the second, and that from the second boiling the contents of the third, but the plan does not seem to have been practically successful. The proof of the condition of the sugar is by *teache*, or touch, or by saccharometer, as in the case of the open-pan boiling, the sirup being withdrawn from the pan by a proof-stick for this purpose. See SACCHAROMETER.

*Second Defecation.* When the panful is brought to a density ranging from 26° to 28° B., where it is about half sugar, it is discharged into caldrons for farther defecation. The heat is kept up in the defecators by means of steam-coils, into which the steam is admitted at will. The liquor is brought to a froth, raising a scum, which is removed; the steam is turned off, and the action repeated each time it comes to a froth, the heat being damped and the scum removed.

*Second Filtering.* The sirup is now turned into the high filters, which are 20 feet high, and charged with bone-black; from them it issues a clear, bright, yellow liquid, ready for the final boiling, which is accomplished in the great vacuum-pan, called the *strike-pan*, where it is concentrated finally, being brought to the stage of crystallization.

*Second Boiling.* It is here boiled at a temperature of 180° Fah., but gradually, as the sirup thickens, the temperature is lowered, until, when the crystals have begun to form, the heat is not greater than 160° Fah. It is now thick with crystals of sugar floating in sirup, and the trial by *teache* is repeated frequently. The engineer peers anxiously through the glass windows at the boiling sirup, and finally makes preparations to discharge the contents of the pan into the heaters below. The sirup falls from the bottom of the strike-pan of a rich auburn color. The great vacuum-pan of the Yngenio San Martin is a magnificent piece of workmanship, costing $70,000, and capable of boiling in a day from 1,100 to 1,500 *panes* or cones of sugar, containing 100 pounds each of green sugar.

The heaters which receive the sirup from the vacuum-pan are kept hot by steam-jackets; their contents are stirred freely, to encourage granulation, and are then removed to the sugar-cones, which stand for a day in the high temperature of the boiling-house, and are then removed to the purgery, where they undergo the claying-process and are deprived of their molasses. The San Martin purgery is 150 × 400 feet, and affords room for 22,220 cones. One floor is pierced for the cones, and the floor below is used for a packing and drying house.

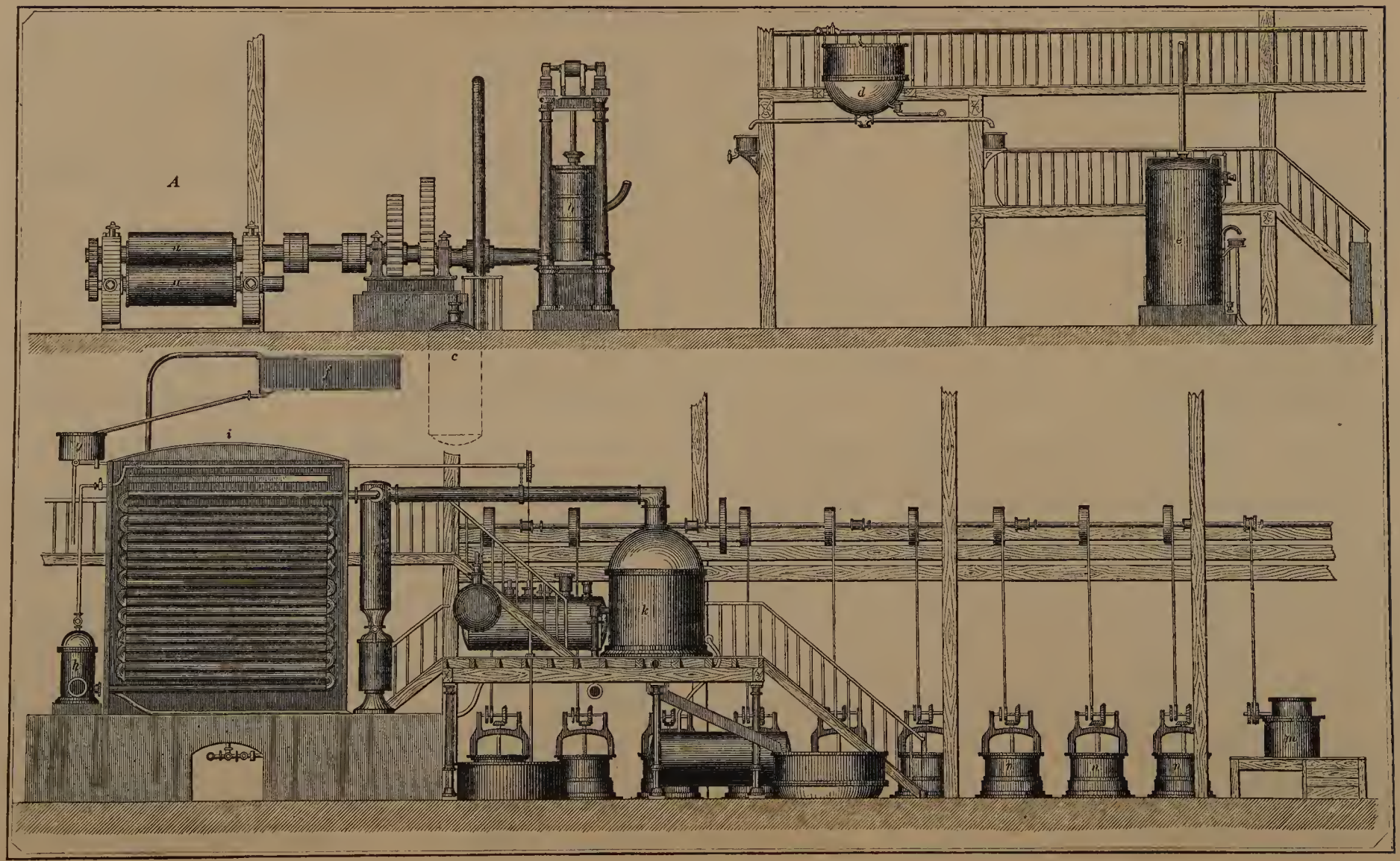
*Drying.* The lower room has double rows of cars, one above another, placed on tracks, and so arranged as to be run out into the sunshine with their loads of moist sugar to dry. The cones are broken into three pieces, according to quality, the base being whiter, the middle a second grade, and the tip being moistened and passed through the centrifugal machine to remove the molasses.

The molasses that drips from the cones in the purgery is reboiled in the vacuum-pan and then granulated in tanks. It is dried by the centrifugal machines, which consist of a wire cage or cylinder revolving rapidly in a case, and expelling the molasses through the meshes of the cylinder. (See CENTRIFUGAL MACHINE.) Steam is sometimes added in the centrifugal dryer to assist in expelling the molasses, thereby whitening the sugar.

The modes of packing do not need description.

Fig. 6053 shows a more modern plan.

*a*, steam-boilers.
*b*, steam-pipe.
*c*, engine.
*d*, vacuum-pan.
*e*, defecator.
*f*, bone-black filter.
*g*, cistern.
*h*, pipe leading to vacuum-pan.
*k*, air and steam exhaust-pipe from pan.
*l*, pan to receive condensed sirup from vacuum-pan.

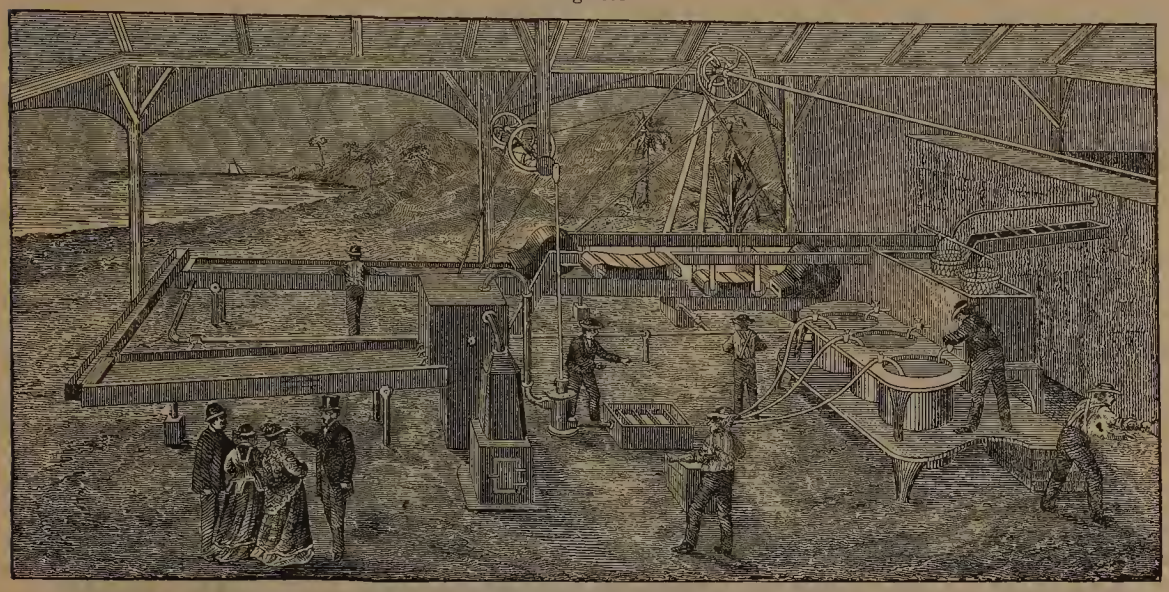



VACUUM-PAN AND SUGAR MACHINERY OF A CUBAN PLANTATION.

PLATE LXVI.

*See page* 2450.

Fig. 6054.



*Aschenbrenner's Sugar-Apparatus.*

Plate LXVI. represents a complete system of sugar-machinery built by M. M. Cail & Co., of Paris, for a Cuban plantation. *A* is the grinding machinery; the rollers *a a* are driven by intermediate gearing from the engine *b*. The expressed cane-juice flows into a tank, whence it is conducted into the filter *c*. When this is sufficiently full, the supply is cut off, and steam admitted through a pipe, forcing the juice up into the purifiers *d*, six in number. These are heated by coils with steam under a pressure of 60 pounds to the inch, and are provided with proper supply and discharge pipes. About three per cent of lime is added to the juice, part being thrown in previous to its withdrawal from the tank.

After being purified by boiling, the juice is filtered through animal charcoal in cylinders *e*, to each of which a three-branched pipe leads for the admission of juice, sirup, and steam as required. Each filter has a perforated false bottom, from whence the juice flows into a tank *e*, and is lifted by steam pressure into a vessel *f*; it thence flows into the vessel *g*, which regulates the supply to the evaporating-condensers *h*, in which a vacuum is maintained, and thence passes through the tubular steam-heated condensers *i*, after which it is pumped into the vacuum-vessel *k*, in which the processes of evaporation and condensation are completed. Separators *l* receive any water or juice that may pass out with the vapor.

The juice, now concentrated to sirup, is clarified by blood in the usual way, and again filtered and concentrated and placed in molds, where it drains and crystallizes. In order to remove any remaining molasses and thoroughly dry the crude sugar formed by this last process, the loaves are ground in crushing-machines *m*, and the pulverized sugar is then placed in the centrifugal machines *n*, driven at the rate of more than 1,200 revolutions per minute, by which the remaining moisture is expelled.

The above machinery is capable of treating 100 tons of cane daily, producing 8 tons of sugar, and cost $ 160,000.

It is claimed that in the ordinary processes of manufacture, less than one half of the saccharine matter in the juice of the cane is extracted as crystallizable sugar.

The apparatus of Dr. Aschenbrenner, shown in Fig. 6054, is designed to produce the sugar in crystalline form, no molasses being formed, unless it is so desired.

The juice from the crushing is delivered through the trough seen to the right; in this are placed two filters of different degrees of fineness, which separate mechanical impurities; the juice then passes through a flannel strainer, of which several are provided, so that one may be removed, washed, and replaced by another, as required, and is then received in a tank, from which it is drawn off into three open kettles having double bottoms and heated by steam, in which it is purified by lime and magnesia, the sediment being drawn off at the bottom. The purified juice then passes through siphons to another filter, which separates any remaining impurities held in suspension. From the filter the juice is pumped into a case, where it is agitated by a paddle-wheel and subjected to the action of sulphurous fumes from a furnace, by which it is bleached, and thence flows into a steam-heated metallic trough, from whence it is conducted to a second and third similar trough successively; at the lower end of the third trough it is subjected to the action of a fan, which cools it and promotes the evaporation of the vapor. It has now become so thick as to require the use of a scraper, which consists of an endless band moving around pulleys and carrying a series of blades; this conveys the sugar to another incline, where it is acted on by a second fan. It is now entirely crystallized, and is removed by hand into a receiver. When desired to produce molasses, a small proportion may be obtained by making the incline of the troughs steeper and dispensing with the use of the fans.

Other plans of treating the cane have been suggested, and in some cases adopted. The following may be mentioned: —

De Mancel and Brafen, of Martinique, obtained U. S. patent, February 22, 1848, for a process of drying and pulverizing sugar-cane, and then washing the saccharine matters therefrom to be manufactured into sugar by evaporation in the ordinary way. The cane is chopped into small pieces by a cane-cutter, is dried in a kiln and ground in a mill. The meal is then placed in tubs, which are tightly closed, and water passed in succession through them till the sugar is all extracted. The filter and boiling-pan conclude the operation. See also DIFFUSION-PROCESS, Fig. 1652.

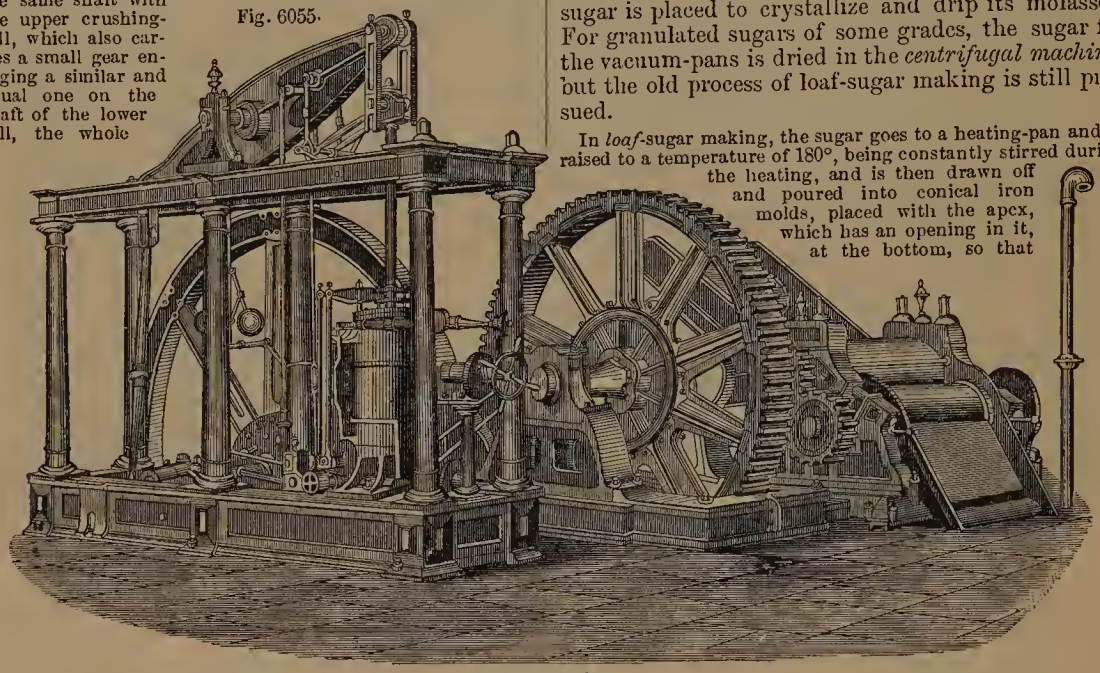
See under the following heads: —

Bagasse-dryer.
Beet-root sugar-machinery.
Blow-up pan.
Bone-black cooler.
Bone-black furnace.
Cane-juice bleacher.
Cane-juice evaporator.
Cane-mill.
Centrifugal filter.
Centrifugal machine.
Charcoal-purifier.
Clarifier.
Claying.
Cleare.
Concrete.
Condenser.
Confection-pan.
Cube-sugar machine.
Defecator.
Diffusion-apparatus.
Drying.
Dunder.
Evaporating-pan.
Evaporator.
Graude.
Monte-jus.
Pot.
Potting.
Potting-cask.
Proof.
Pucheux.
Purgery.
Saccharometer.
Sap-boiler.
Sap-spout.
Skip.
Skipping-teache.
Sorghum-evaporator.
Sugar.
Sugar-cutting machine.
Sugar-drainer.
Sugar-evaporator.
Sugar-filter.
Sugar-furnace.
Sugar-machinery.
Sugar-mill.
Sugar packer.
Sugar-pan.
Sugar-pan lifter.
Sugar-refinery.
Sugar-sifter.
Swing-pan.
Teache.
Vacuum-pan.

**Sug'ar-mill.** A mill for expressing the juice from sugar-canes. It has usually three rollers; two in the same horizontal plane, and the third over and between these. The canes are fed in between the upper and first horizontal rollers, where they receive their first squeeze, the juice running down into a trough at the base of the mill; they then travel onward, receiving a second squeeze between the top roller and the second horizontal roller, which extracts the remaining juice. The residual woody fiber, termed bagasse, when dried, is used as fuel for the furnace-boiler. Fig. 6055 illustrates an approved form of sugar-mill, with the beam-engine for driving it.

In the mill (Fig. 6056), the crushing-rolls are operated directly from the fly-wheel shaft of the steam-engine through three pairs of interposed gear-wheels and pinions; the last gear-wheel is on the same shaft with the upper crushing-roll, which also carries a small gear engaging a similar and equal one on the shaft of the lower roll, the whole forming a very compact and simple arrangement. See also CANE-MILL.

Fig. 6055.

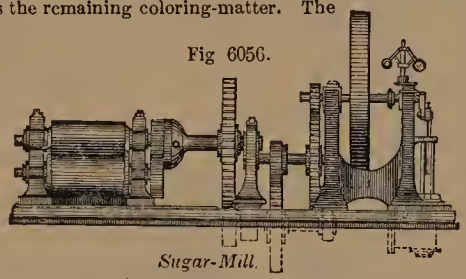


*Sugar-Mill*

**Sug'ar-mold.** A conical iron mold in which sugar is placed to crystallize and drip its molasses. For granulated sugars of some grades, the sugar for the vacuum-pans is dried in the *centrifugal machine*, but the old process of loaf-sugar making is still pursued.

In *loaf*-sugar making, the sugar goes to a heating-pan and is raised to a temperature of 180°, being constantly stirred during the heating, and is then drawn off and poured into conical iron molds, placed with the apex, which has an opening in it, at the bottom, so that whatever liquor has remained may drain off through the opening. After several hours, the *loaves* left in the molds are *liquored* by pouring in at the top a clear solution of pure sugar, which removes the remaining coloring-matter. The

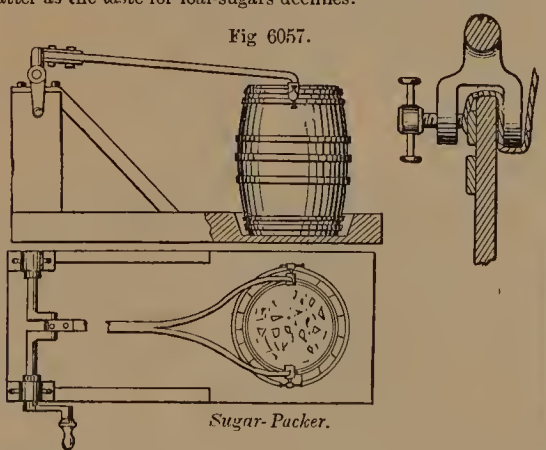
Fig 6056.



*Sugar-Mill.*

liquoring-process is sometimes repeated several times, until the loaves become perfectly blanched. Then they are left two or three days in a drying-room heated by steam, are trimmed, if necessary, in a lathe, and are finally papered for market. The trimmings, the draining from the molds, etc., are saved for the manufacture of inferior grades of sugar. The old method of employing molds takes a longer time and is more expensive than the centrifugal process, and is gradually being superseded by the latter as the taste for loaf-sugars declines.

Fig 6057.



*Sugar-Packer.*

**Sug'ar-pack'er.** A machine for packing sugar in barrels.

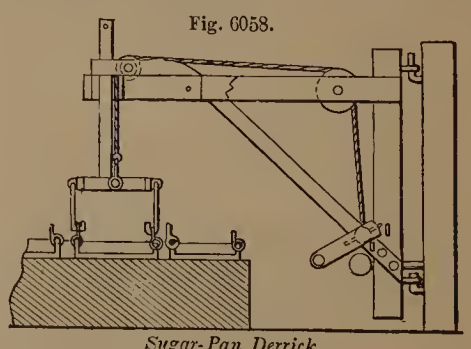
In the example, the barrel to contain the sugar rests in a cavity in the platform, and by means of a forked bar with a screw clamp on each fork end, the upper rim of the barrel, with the filling bag, is tightly clamped, while the single opposite end of the forked bar is fitted to a crank, from which it receives and imparts to the barrel a reciprocating motion.

**Sug'ar-pan.** See EVAPORATOR; SUGAR-FURNACE; SUGAR-MACHINERY; VACUUM-PAN.

**Sug'ar-pan Lift'er.** A crane rigged in a sugar-house to lift flat pans from the furnace. It is only seen in a certain arrangement of devices, where flat pans travel along the walls of the furnace as the boiling proceeds, being lifted at the rear end as the boiling is completed, and the pan set aside that the contents may granulate.

The hoisting-cord is attached to a frame from whose four corners depend hooks for engagement with the rings at the corners of the pan. From the center of the frame arises a sliding upright which passes through the derrick to steady the frame.

Fig. 6058.



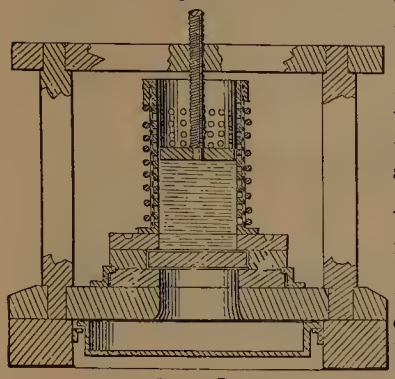
*Sugar-Pan Derrick.*

**Sug'ar-press.** A machine for expediting the drainage of the molasses from the sugar.

The box has perforated sides, so that the molasses expressed from the crude sugar may escape and be collected outside. After the pressure has been carried to a sufficient extent, a wedge in the platform, upon which the press-box stands, directly beneath the box, is withdrawn, and the dry sugar falls through the opening into a box below.

**Sug'ar-re-fin'ing.** The process of purification or discolorization of raw or brown sugar.

Fig. 6059.



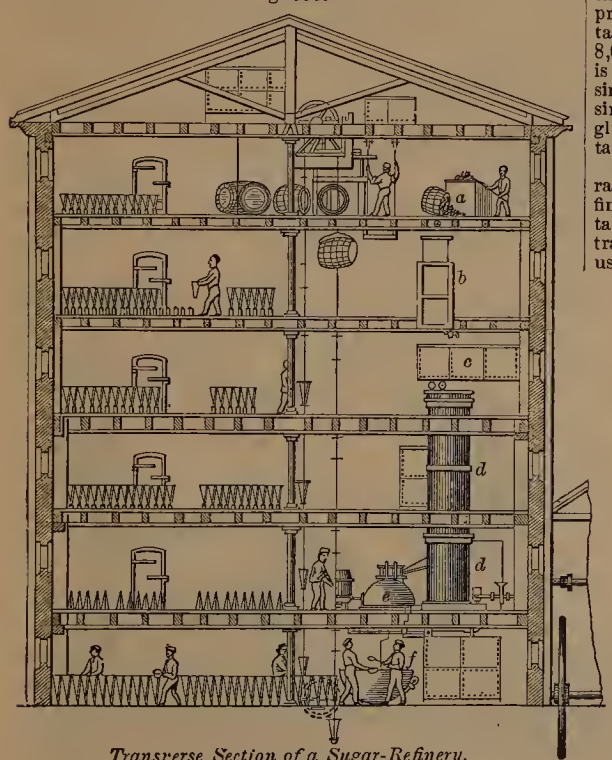
*Sugar-Press.*

The sugar is,—

1. *Dissolved* in water, a little blood and lime-water being added.
2. *Filtered* in bags, to remove feculences.
3. *Filtered* through animal charcoal, to remove color.
4. *Boiled* in a vacuum-pan, to concentrate it.
5. Crystallized in molds.

Fig. 6060 is a transverse section of a sugar-refinery. The packages are hoisted to the top floor of the building, emptied, and transferred to the dissolving-pan *a*, where the sugar is mixed with water and agitated by a mechanical stirrer. A temperature of about 165° Fah. is maintained in the pan by means of a steam-coil, and the solution, having been brought to the specific gravity of about 1.25, or 29° Beaumé, is transferred to bag-filters within cases *b* (see BAG-FILTER). The sirup passing through these is drawn off into a vat *c* on the floor below, and thence conducted to the bone-black filters *d*; the decolorated liquid, after passing the filters, is drawn into vacuum-pans *e* and evaporated at a heat of 170° to 180° Fah. at the beginning of the process, reduced to about 145° when crystallization is sufficiently advanced. While yet sufficiently fluid, it is let down through a valve in the bottom of the pan to the heater *f*, where its temperature is raised to 180°, and stirred until crystallization is complete. The moist crystalline mass is then drawn off into ladles and transferred to conical molds, for making loaf-sugar. After standing several hours to drain and solidify, the molds

Fig. 6060.




*Transverse Section of a Sugar-Refinery.*

and their contained loaves are conveyed to an apartment above, kept at a temperature of about 100°, where they are still farther drained, and a clear saturated solution of sugar poured upon them which percolates through and whitens them; this is repeated several times. When the proper color is produced, they are transferred to a stove heated to 130° or 140°, where they are kept two or three days, till they are baked thoroughly dry. The drainage from the molds is again concentrated by boiling, to form a lower grade of sugar; the uncrystallizable portion remaining after this operation constitutes treacle or sirup.

For producing granulated sugar, the processes, previous to boiling, are conducted as before. Large vacuum-pans, having extra heating-coils are employed, and the boiling is continued until crystals begin to appear, when more liquor is added, and the concentration continued. This process is repeated several times, to cause the formation of large crystals. When sufficiently concentrated, one half the liquor is removed to the heater, the remainder being left to assist in the formation of crystals in the next charge. After being thoroughly crystallized in the heater, the moist mass is transferred to the centrifugal machine, the rapid rotation of which soon expels the moisture. In order to cleanse the crystals, a small quantity of liquor is sprinkled upon them while in the machine. The percentage of sugar obtained in this and at each subsequent crystallization is considerably less than that obtained in making loaf-sugar, though the total product does not vary materially. The drainage is diluted, filtered through animal charcoal, boiled, and again passed through the centrifugal machines, forming a second quality of sugar having smaller crystals. A third, and sometimes a fourth quality of sugar is produced by similarly treating the resulting drainings.

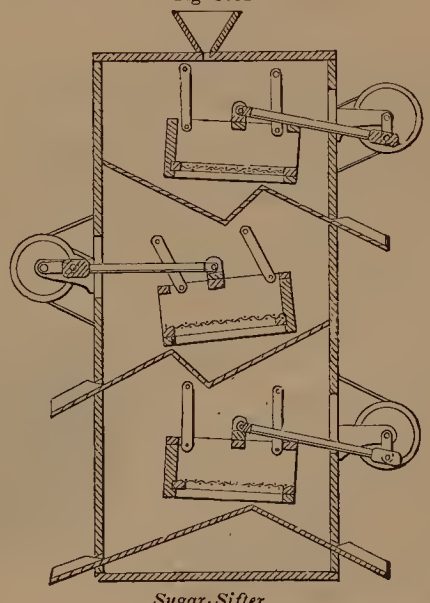
M. Van Goethem, a Belgian sugar-refiner, has a machine in which fifty sugar-loaves are ranged radially in a kind of horizontal wheel, and then the whole is made to revolve with the speed of 800 revolutions in a minute. The proper liquid is applied by a beautiful contrivance; and in about twenty minutes the fifty loaves of sugar are found to be not only freed from molasses, but rendered almost completely dry. Many days would be required to effect this by the old method.

Boivin and Loiseau's process is founded upon the use of the sucrate of the hydrocarbonate of lime, for the purification of raw sugar instead of blood, bone-black, etc. For the preparation of this compound, milk of lime is made from the waste sweet liquors of the refinery, and enough sirup added to give the mixture 20° Baumé. This is well agitated, and run through a cooler until the temperature sinks to 68° Fah. From the agitators the liquid flows into vats, where it is partially saturated with carbonic acid: the gas is passed through until the desired precipitate of sugar, lime, and carbonate of lime settles as a gelatinous mass. After the purifying agent has been thus prepared, it is applied in the following manner: —

The raw sugar is dissolved in a cylindrical pan, similar to a vacuum-pan, under diminished pressure. Revolving buckets carry it into receivers over the boilers, and from these it is permitted to flow into the boilers, where it comes in contact with the sucro-carbonate of lime previously introduced, in a quantity proportional to the percentage of raw sugar. They generally take about 650 gallons of the gelatinous sucro-carbonate to 8,000 pounds of sugar. Water is added if necessary; the whole is boiled, and in this way the solution and clarification are simultaneously accomplished. One advantage is that when sirup is boiled in presence of lime, ammonia is evolved, all glucose is decomposed, and anything likely to produce fermentation is destroyed.

The sirup from the boilers is filtered, the excess of lime separated by carbonic acid, and it is farther concentrated and finished in the usual manner. The slimy residues and precipitates are squeezed out in filter-presses until they contain no trace of sugar, and can be thrown away. The wash-water is used in the preparation of new material.

Fig. 6061.

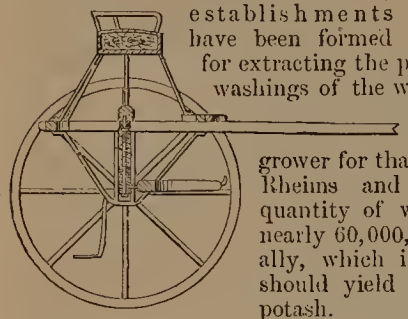


*Sugar-Sifter.*

**Sug'ar-sift'er.** A machine for sorting grades of crushed or ground sugar according to fineness of grain. The reciprocating sieves are arranged in a frame, one below the other. One end of each sieve is left open, to allow the sugar to fall on the discharge-spouts, which are arranged alternately on opposite sides of the frame. The sugar passes alternately through the sieves and conducting-troughs and is discharged below.

**Su'int.** The natural grease of wool. It consists of insoluble saponaceous matter together with a soluble salt containing from 15 to 33 per cent of potash. In the great wool-growing districts of France, establishments have been formed for extracting the potash from the washings of the wool, which are purchased from the wool-grower for that purpose. At Rheims and Elbœuf, the quantity of wool washed is nearly 60,000,000 lbs. annually, which it is estimated should yield 3,000,000 lbs. potash.

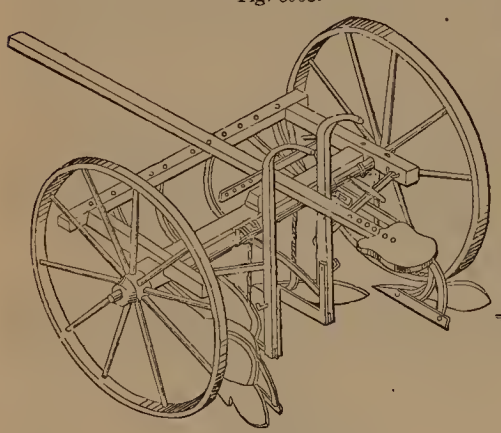
Fig. 6062.



*Sulky.*

**Sul'ky.** A light two-wheeled vehicle, having a seat for a single occupant, used as a pleasure-carriage and for trials of speed between trotting-horses.

Fig. 6063.



*Sulky-Cultivator.*

In the example, the usual elliptical spring is associated with a spiral spring near each wheel. Braced guide-rods from the frame embrace the axle.

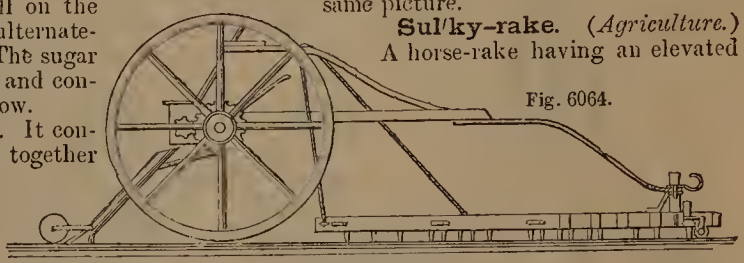
**Sul'ky-cul'ti-va'tor.** One having a seat for the rider, who manages the plows, moving them to the right or left as the plants in the rows may require.

**Sul'ky-har'row.** One having a wheeled carriage and seat for the rider. The fore part of the harrow rests upon an adjustable caster, and is connected to the front end of a flexible bar attached to the sulky-hounds. The draft-hook is at this point.

**Sul'ky-plow.** One having a seat for the plower. In the example, a portion of the seat is just apparent beyond the pulley *G*, on which the plow-supporting chain winds. The Bayeux tapestry, which represents the invasion of England by William I., and the death of Harold at Hastings, shows a plow having a pair of wheels, on which a man rides and drives a horse. A square harrow and a man sowing from a basket are in the same picture.

**Sul'ky-rake.** (*Agriculture.*) A horse-rake having an elevated seat for the driver. Levers easily accessible to the hand or foot are provided for lifting the rake when it has accumulated sufficient hay to form a windrow, and for holding it clear of the ground altogether when required. The former operation is sometimes performed by means of automatic devices. See HORSE HAY-RAKE.

Fig. 6064.



*Sulky-Harrow.*

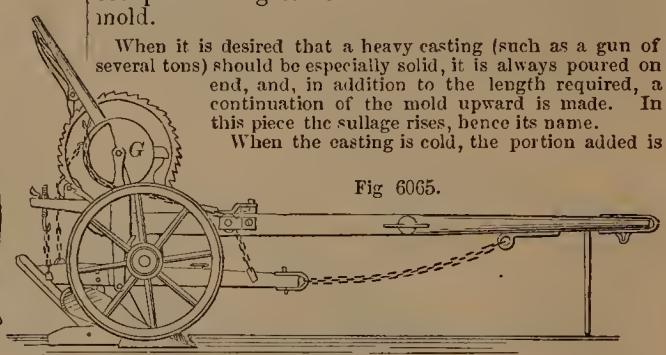
**Sul'lage.** 1. (*Founding.*) The scoria which rises to the surface of the molten metal in the *ladle*, and which is held back when pouring to prevent porous and rough casting.

2. (*Hydraulic Engineering.*) Silt and mud deposited by water.

**Sul'lage-piece.** (*Founding.*) A *dead-head*, or *feeding-head*. A piece of metal on a casting which occupies the ingate at which the metal entered the mold.

When it is desired that a heavy casting (such as a gun of several tons) should be especially solid, it is always poured on end, and, in addition to the length required, a continuation of the mold upward is made. In this piece the sullage rises, hence its name. When the casting is cold, the portion added is cut off, and, with it, the impurities which floated up there are removed.

Fig 6065.




*Sulky-Plow.*

**Sul'phur-fur'nace.** Native sulphur, when comparatively pure, is simply melted in a kettle (*A*, Fig. 6067), the stones and impurities re-

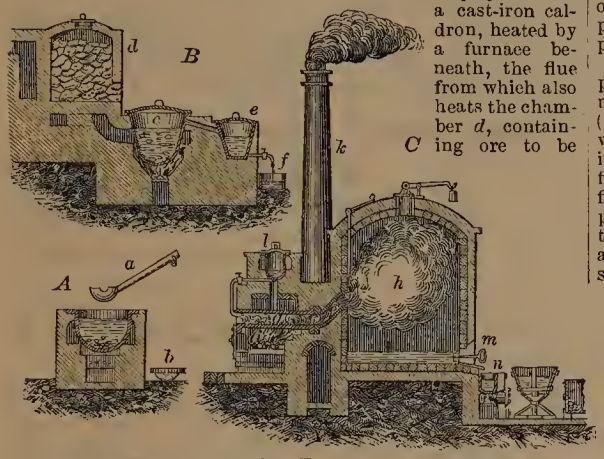
Fig. 6066.

*Sulky-Rake.*

moved by a *ladle a*, and the mass cast in a mold *b* previously moistened with water, to prevent adhesion.

The stones and gangue containing the sulphur are sometimes roasted in a tall furnace, the fluid sulphur being drawn off at the bottom: distillation is, however, preferable. For this the apparatus *B* is employed. *c* is a cast-iron caldron, heated by a furnace beneath, the flue from which also heats the chamber *d*, containing ore to be

Fig. 6067.




*Sulphur-Furnace.*

transferred to the caldron The distillate is condensed in the vessel *c*, and in the fluid state is drawn off into *f*.

*C* represents Michel's apparatus as improved by Lamy for refining crude sulphur. It comprises two cast-iron cylinders, one shown at *g*, used as retorts, and a condensing-room *h*. The retorts are heated by a furnace *i*, the smoke of which is carried off by the chimney *k*. The crude sulphur is placed in the vessel *l*, where it is melted and partially refined, passing into the retort *g*, where it is sublimed, condensing in the chamber *h*, whence it is withdrawn through the tap-hole *m*, fitted with a conical plug, being received in the vessel *n* and then cast into rolls.

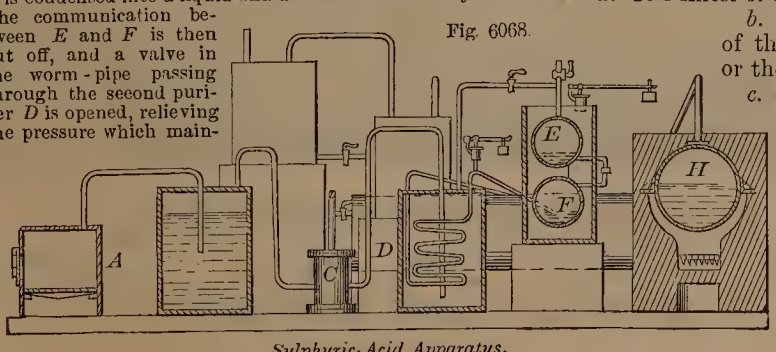
For over three centuries most of the sulphur made use of in Europe and America has come from the island of Sicily, chiefly because it can be so conveniently reached. The article, however, being of volcanic origin, is abundantly found wherever there are, or have been, volcanoes. A discovery has recently been made of a large and very rich deposit of this valuable mineral on the island of Saba, one of the Dutch West Indies. A New York company has found the average yield of this deposit to be over 60 per cent of sulphur, of excellent quality, and in quantities practically inexhaustible. The island is within a hundred miles of the port of St. Thomas.

It is also rumored that a discovery of sulphur has been made on Rabbit-Hole Mountain on the line of the Central Pacific Railway in Humboldt County, Nevada, at a place called "Inferno." The mountain is said to be a mass of sulphur, yielding from 92 to 96 per cent of the pure article, and is being shipped to Carson and San Francisco at the rate of 10 to 20 tons a week. California procures some sulphur from Japan as well as from Sicily; but this Nevada product is said to excel either.

**Sul-phu'ric-ac'id Ap'pa-ra'tus.** An apparatus in which sulphur is sublimed and the acid condensed.

Fig 6068 illustrates Tait's apparatus for producing sulphuric acid by means of sulphurous and nitric-acid gases condensed by pressure into the liquid form. *A* is a furnace in which the sulphur is burned. *B*, the first purifier; *C*, a pump which exhausts the gas from the first purifier, and forces it into the second purifier *D*, whence it is driven into the condenser *E*, where it is condensed into a liquid and drawn off into the cylinder *F*. The communication between *E* and *F* is then cut off, and a valve in the worm-pipe passing through the second purifier *D* is opened, relieving the pressure which main-

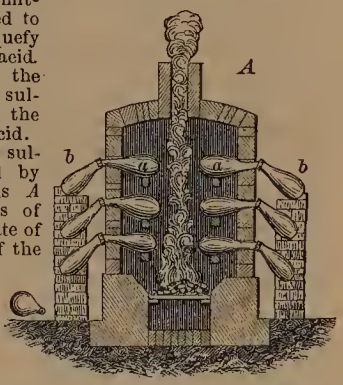
Fig. 6068.



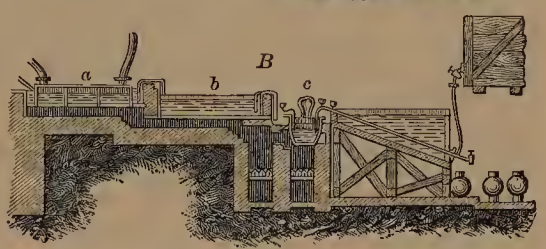

*Sulphuric-Acid Apparatus.*

tains the sulphurous acid in liquid form, and permitting it to assume the gaseous condition. It flows through this pipe into a receiver, where the nitric-acid gas, oxygen, and steam from the boiler *H* are admitted, and is then submitted to a pressure sufficient to liquefy both it and the nitric acid. The reactions between the oxygen and the nitric and sulphurous acids result in the production of sulphuric acid.

Fig. 6069.




Fuming or Nordhausen sulphuric acid is prepared by means of the apparatus *A* (Fig. 6069). 2½ pounds of vitriol stone (dried sulphate of iron) are placed in each of the flasks *a a*, etc., made of fire-clay, whose necks pass through the walls of the furnace; on the first application of heat only sulphurous acid and weak




*Sulphuric-Acid Apparatus.*

hydrated sulphuric acid pass over, which are usually allowed to escape. When white vapors of anhydrous sulphuric acid appear, the necks of the flasks are luted to the receivers *b b*, each of which contains 30 grammes water, and the distillation continued from 24 to 36 hours, when the flasks are again filled with the sulphate; this operation is repeated four times, before the acid is deemed sufficiently strong. Its specific gravity varies from 1.86 to 1.92. This variety is principally used for dissolving indigo; 1 part being mixed with 2 of the common acid for this purpose.

*B* is the apparatus employed for concentrating the ordinary sulphuric acid of commerce. The weak acid, prepared by the absorption in water of the gas evolved by calcining pyrites, is transferred to the leaden chamber *a*, connected by a siphon with the similar chamber *b*; the latter and the retort *c* are heated directly by furnaces, and the former by a flue therefrom; during the transference from the first to the second chamber the acid acquires a higher degree of concentration, and is then, by means of a second siphon, conveyed from thence into the retort, where water and weak acid are driven off, strong acid, of specific gravity 1 78 to 1 8 remaining in the retort, whence it is withdrawn by a platinum siphon of peculiar construction. The retort is also in many cases made of platinum, but glass is also frequently employed.

**Sul'phur-ing.** 1. (*Bleaching.*) A process of bleaching by exposure to the fumes of sulphur. It is adopted with straw-braid, straw hats, silks, woolens, etc. Sulphurous acid is the bleaching agent, and may be applied by means of a watery solution.

2. (*Calico-printing.*) The process of exposing printed calicoes to sulphurous-acid fumes. It is an incident in the fixation of *steam-colors*.

**Sum'mer.** 1. (*Carpentry.*) A horizontal beam or grinder. A *summer-tree*.

*a*. The lintel of a doorway.

*b*. A floor timber receiving the ends of the joists and supporting the floor or the ceiling, as the case may be.

*c*. A beam resting on pillars, as in the case of a shop front, and supporting the superincumbent wall with which its front face is flush. Called a *breast-summer*.

2. (*Masonry.*) The first stone or beam laid over a column or beam. A *lintel*.

**Sum'mer-tree.** A *breast-summer* or *summer*. A horizontal beam brought even with the face

(breast) of a wall, to support a wall above a gap or opening, as a store front, for instance.

**Sum'mit.** The highest elevation of a railway or canal.

**Sum'mit-lev'el.** A comparatively level place of a railway, with inclined planes on either side of the mountain. The level *pond* of a canal with lockage at either end, for descent.

**Sump.** 1. (*Mining.*) *a.* A pit or well in the floor of a mine at the bottom of an engine-shaft, to collect the water, which is pumped from thence.

*b.* A catch-water drain.

*c.* The part of a judd of coal first brought down.

2. (*Metallurgy.*) A pit of stone at a furnace to collect the metal at its first fusion.

3. (*Salt.*) A pond of water for salt-works.

**Sump-fuse.** A thick kind of fuse used for blasting under water. The fuse composition is inclosed in a hempen cord, which is twisted, overlaid with another cord, and varnished. The end is placed in the water-proof cartridge and tied; the end of the fuse is then dipped in pitch, and the protected fuse is ready for duty.

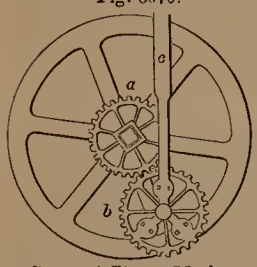
**Sump'ing.** (*Mining.*) A small square shaft, generally made in the air-headings, when crossing faults, etc., or to try the thickness of the seam.

**Sump'ing-shot.** (*Mining.*) A charge of powder for bringing down the sump, or for blowing the stone to pieces in a sinking pit.

**Sum'pit.** The arrow of the *sumpitan*, or blow-tube of Borneo. See ARROW; AIR-GUN, page 48.

**Sump-plank.** (*Mining.*) Strong balks of timber bolted together, forming a temporary bottom or scaffolding for the shaft.

Fig. 6070.




*Sun-and-Planet Motion.*

**Sump-shaft.** (*Mining.*) The engine-shaft.

**Sun-and-Plan'et Mo'tion.** Invented by James Watt as a substitute for the crank. Watt had applied the crank to the use of his "fire-engine," as he called it, — what was eventually termed a steam-engine. A spying fellow saw the value of the application, and, rushing to London, obtained a patent. See CRANK.

The central gear *a* is called the *sun-gear*, and the outer one *b* the planet-gear. In the form shown in the illustration, the revolution of the planet-wheel rotates the sun-wheel, together with its shaft and the fly-wheel. For this purpose the planet-wheel *b* is fast to the pitman *c*, and its axis is caused to revolve around the wheel without the rotation of the planet-wheel on its own axis. See PLANET-WHEEL and EPICYCLOIDAL WHEEL.

**Sun-burn'er.** A large reflecting cluster of burners placed beneath an opening in the ceiling, for lighting and ventilating a public building.

**Sun-case.** (*Pyrotechny.*) A strong paper case filled with a composition which does not burn so fast as rocket-composition. They are driven similarly to rockets, but solid, and are attached, at short intervals apart, to wooden frames, usually circular, to produce what are called stationary and revolving *suns* and other similar effects in pyrotechny, giving out a steady and brilliant stream of light while burning.

**Sun-di'al.** A time-measurer, in which a gnomon casts a shadow upon a graduated plate.

Said by Pliny to have been invented by Anaximander of Miletus, 550 or 562 B. C. The dial of Ahaz, referred to by Hezekiah, was near two centuries precedent to that of the Grecian. It probably originated with the Chaldees or with the race of Asiatic descent known to us as Egyptians, who were the dwellers in the valley of the Nile at the period of Abraham, and long previous. See DIAL.

**Sunk Coak.** (*Carpentry.*) A mortise or recess in the scarfed face of a timber, and designed to receive the counterpart *coak* or tenon of the other timber. See SCARF.

**Sunk'en Bat'ter-y.** (*Fortification.*) In a sunken battery all the earth from the parapet is taken from the interior space, which is lowered from 2 feet to 3½ feet, according to the hight of the gun-carriages to be used. This kind of battery can be constructed in less time than an elevated battery, the mass of earth in the parapet being smaller, but its command over the surrounding country is of course less.

**Sunk'en Ves'sels, Rais'ing.** Apparatus for lifting foundered vessels.

Sowesbutt's apparatus for raising sunken vessels consists of a number of cases, made just sufficiently heavy to sink when filled with water; each contains a metallic receiver filled with compressed air. They are lowered from the wrecking vessel and attached along the sides of the ship by divers; when the arrangements are complete, valves in the receivers are opened, either by the divers or by self-acting mechanism, and the compressed air thus liberated expels the water from the pontons, which buoy up the vessel. See also Figs. 1617, 4148.

**Sunk Fence.** A ditch with a retaining-wall on one side.

No portion projects above the general level of the ground, and it is not visible at any great distance. For this reason it is also known as a *ha-ha* fence. It is used upon the edge of a garden bordering upon a park, so as to give an apparently greater extent to the home grounds.

**Sunk Mo'tions.** (*Gearing.*) The driving-gear of a rolling-mill, etc., which is below the level of the floor. The iron floor which covers it is called the *standing*. The sunk motions of the Corliss engine-shafting, Machinery Hall, Centennial grounds, weigh 200 tons.

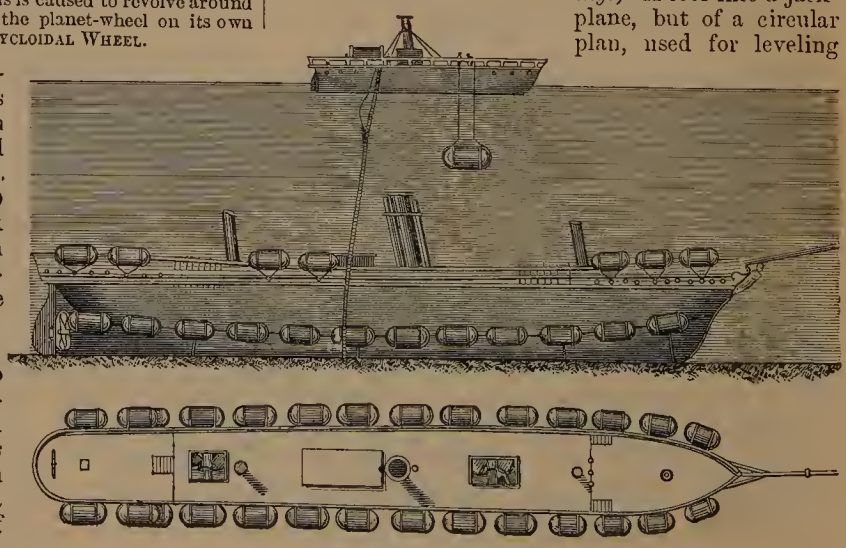
**Sunk-pan'el Ceil'ing.** One divided off into recessed compartments, with roses in the middle and bolection moldings around them.

**Sunn.** An East Indian fiber, used in place of hemp.

**Sun-pic'ture.** A name applicable to all kinds of pictures produced by the action of light upon sensitized surfaces. A *photograph*, or *heliograph*.

**Sun-plane.** (*Coopering.*) A tool like a jack-plane, but of a circular plan, used for leveling

Fig. 6071.



*Raising Sunken Vessels.*

down the ends of the staves of a cask or barrel. The groove for the head is then made by the *croze*, and the chamfer of the *chime* is made by the *howel*.

Fig. 6072.

*Sunk Fence.*

**Sun-shade.** 1. A parasol.

2. An awning or canopy.

**Su-per-fine' File.** A dead-smooth file.

**Su-pe'ri-or.** (*Printing.*) A character which stands above the general line of the lower-case letters; commonly employed for notes and references.

Fig. 6073.

*Sun-Plane.*

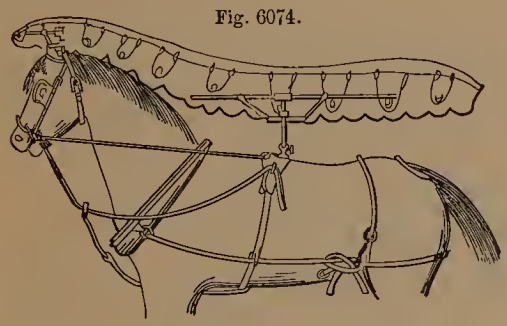
Superior letters.....$B^a$ $C^b$ $D^m$

Superior figures.....$A^4$ $H^{10}$ $L^2$

**Su-pe'ri-or Slope.** (*Fortification.*) A slope extending from the *crest* of the parapet to the summit of the *exterior slope*, with which it forms an obtuse angle. See PARAPET.

**Su-per-roy'al.** (*Paper.*) A size of drawing and writing paper measuring $27\frac{1}{2} \times 19\frac{1}{4}$ inches, and weighing according to quality and thickness.

Fig. 6074.



*Sun-Shade for Horses.*

**Sup'ple-ment'a-ry En'gine.** An auxiliary steam-engine, for feeding the boiler when the main engine is at rest; for working the pumps, cargo-winch, etc.

**Sup-ply'-roll'er.** (*Printing.*) An intermediate working-roller.

**Sup-port'.** A term of very general import. A stand, frame, or bed for an engine, machine, apparatus, implement, tool.

(*Chemistry.*) A stand for a blow-pipe lamp, crucible, retort. (See Fig. 4279.) A rack for test-tubes.

**Sup-port'er.** 1. (*Surgical.*) These are of various kinds, as indicated by their names. Most of them are considered under the following heads: —

| | |
|---|---|
| Abdominal supporter. | Pessary. |
| Body-supporter. | Pile-supporter. |
| Catamenial supporter. | Shoulder-brace. |
| Fracture-supporter. | Spinal supporter. |
| Hernia-supporter. | Testes-supporter. |
| Menstrual supporter. | Uterine supporter. |
| Obstetric supporter. | Vaginal supporter. |

2. (*Shipbuilding.*) A knee-piece of timber bolted firmly beneath the cathead, to reinforce it when sustaining the weight of the anchor.

*b.* A piece bolted to the hounds of a mast for supporting the trestle-tree. See BIBB.

**Sup-pos'i-to-ry.** (*Surgical.*) *a.* A plug to hold back hemorrhoidal protrusions.

*b.* A medicinal ball introduced *per ano*.

**Sur'base.** 1. (*Architecture.*) A cornice or series of moldings at the top of a pedestal, podium, etc.

2. (*Joinery.*) A board running round a room on a level with the top of the chair-backs.

**Sur'based Arch.** (*Architecture.*) An arch whose rise is less than half the span.

**Sur'cin-gle.** (*Saddlery.*) A belt or girth to be passed around a saddle, pad, or blanket, to fasten it to the horse's back.

**Sur'face-chuck.** (*Lathe.*) A face-plate chuck to which a flat object is dogged for turning.

The backs of stereotype-plates may be thus turned off.

The magnetic chuck will grasp iron disks without clasp or dog.

**Sur'face-con-dens'er.** 1. (*Steam-engine.*) A chamber or congeries of pipes in which steam from the cylinder is condensed. Invented by Napier.

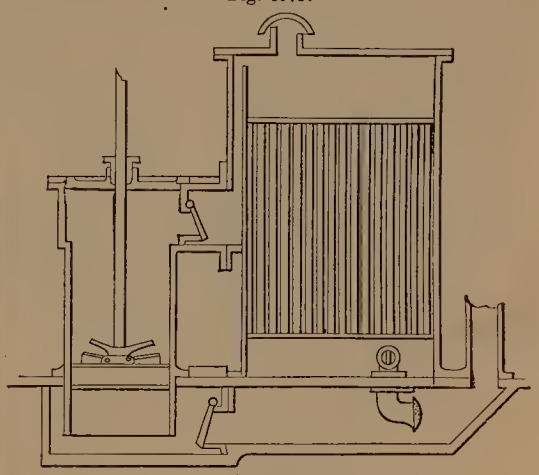
It generally consists of a large number of brass tubes about $\frac{1}{2}$ inch in diameter, united at their ends by means of a pair of flat, steam-tight vessels, or of two sets of radiating tubes. This set of tubes is inclosed in a casing through which a sufficient quantity of cold water is driven. The steam, being led by the exhaust-pipe to one end of the set of tubes, is condensed as it passes through them, and arrives in a condensed state at the other end of the apparatus, whence it is pumped away by the air-pump.

The *surface-condenser* was designed especially for marine engines, to avoid the mixing of the cold salt-water with the water of the condensed steam, which takes place by the use of the injection-condenser, usual in land engines. With marine engines, the cold-water cistern is supplied from the sea, and the constant addition of salt-water in the form of injection, which eventually passes from the hot-well to the boiler, causes the accumulation of salt in the boiler, which is got rid of by occasional *blowing-out* or by a pump. See BRINE-PUMP.

Brunel's surface-condenser was patented in England in 1822, and consists of clusters of pipes communicating with steam-mains and surrounded by the water of the cold-water cistern.

Napier's condenser was a casing around the engine-room, around which the sea-water flowed, entering before and passing out abaft.

Fig. 6075.



*Church's Condenser.*

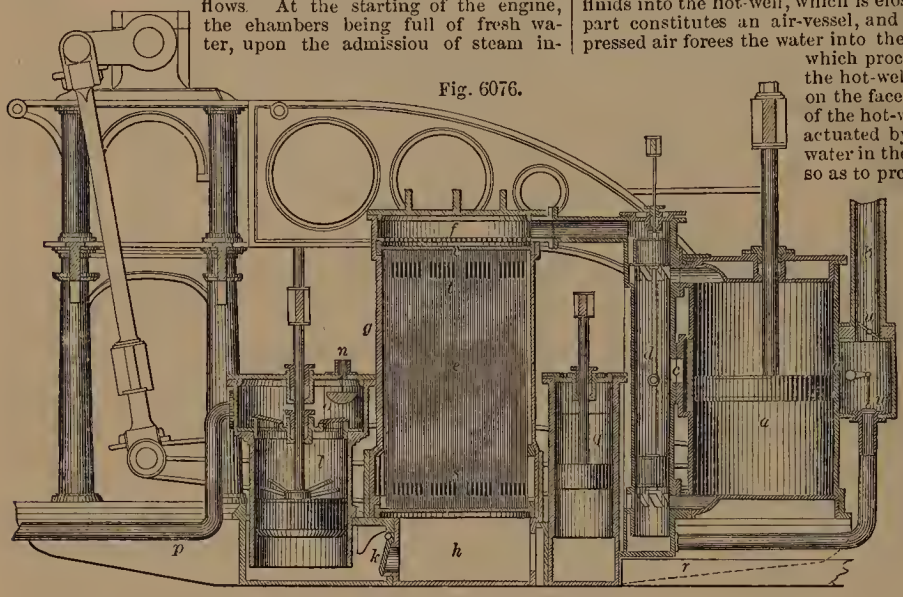
Fig. 6075 is an instance of a surface-condenser for the injection-water of a condensing steam-engine, and may be termed a combined *injection* and *surface* condenser, the surface-refrigeration being applied to the fresh water, which is injected into the condenser to condense the steam.

As has been stated, the cold-water cistern is the usual source of supply for the jet of cold water which is injected as a spray into the condenser. This cistern is supplied from the sources at hand on land, and on our rivers and lakes it is furnished with fresh water, and at sea its contents are salt water.

When the latter is used as injection-water, salt gradually accumulates in the boiler, and on reaching a certain degree of saturation must be removed by "blowing out." (See SALINOMETER.) This condenser aims to keep the contents of the boiler fresh by returning the condensed fresh water to the boiler unmixed with salt water; the latter only being used to cool the condensed water, so that it may be used for the purpose of an injection-spray.

The *refrigeratory* consists of three compartments, the upper one being connected with the lower one by means of a number of small pipes which traverse a cistern, through which a stream of cold sea-water constantly flows. At the starting of the engine, the chambers being full of fresh water, upon the admission of steam in-

Fig. 6076.



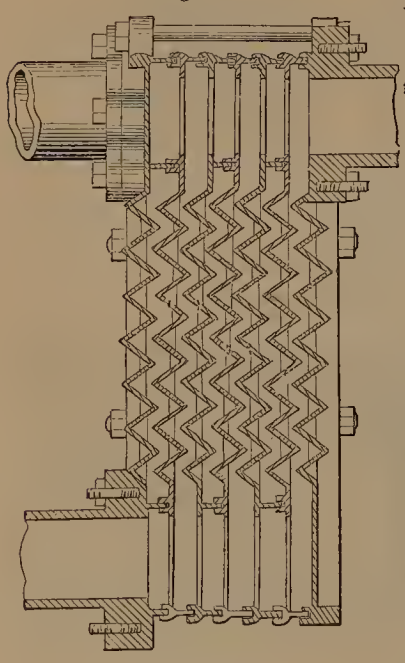

*Hall's Condenser.*

to the condenser by the pipe, the injection-cock is opened, and the injection-water is distributed in a shower amidst the steam by the rose; the condensed and injection pass together through the foot valve-way into the chamber beneath the air-pump, by whose bucket they are lifted and discharged by another valve-way into the upper chamber, to be again cooled in descending through the pipes which are surrounded by the cold sea-water in the cistern. Here the temperature is again reduced, so that the water becomes again effective in an injection-spray.

Hall's condenser (English) consists of a cast-iron vessel *f g h* divided into three compartments by two horizontal tube-plates. Into these plates are secured the ends of a vast number of copper tubes *e* of small diameter, which form a communication between the upper chamber *f* and the lower chamber *h*. Through the middle compartment *g* a stream of cold sea-water is maintained by means of a cold-water pump *q* and the passages *r s t*, of which the former is the cold-water induction pipe, and the other two are respectively the induction and eduction ports by which the water enters and leaves the compartment *g*, from whence it is discharged into the sea.

The upper chamber *f* communicates with the eduction steam passage from the cylinder *a* and valve chamber *d*; and the lower chamber *h* communicates by the foot valve-way *k* with the well of the air-pump *l*.

Fig. 6077.



*Surface-Condenser.*

The steam from the eduction-pipe, entering the upper chamber *f*, is instantly dispersed through the condensing-tubes *e*, which are surrounded by cold sea-water, and is thereby brought into a liquid condition, and falls in a shower into the lower compartment *h*, from whence it is drawn, together with the air and uncondensed vapor, by the air-pump *l*, which delivers the said fluids into the hot-well, which is closed at top, so that the upper part constitutes an air-vessel, and the elasticity of the compressed air forces the water into the boiler through the pipe *p*, which proceeds from the lower part of the hot-well to the feed-valves or cocks on the face of the boiler. On the top of the hot-well is placed a *snift*-valve *n*, actuated by a float *o* to maintain the water in the hot-well at a certain hight, so as to prevent air from entering the boiler along with the water. If the air accumulate at the upper part of the hot-well and the water sink below a certain level, the float descends and opens the valve, when a portion of air escapes and restores the desired condition.

The whole of the steam is condensed and the water returned to the boiler, but, to compensate for loss at the safety-valve and leakage, a still is inserted in the top of the boiler, and connected by a pipe and cock with the upper chamber *f* of the condenser. This still is charged with sea-water, and when the water in the boiler is too low, the cock is opened, and, a communication being thus established with the condenser, a partial vacuum is formed in the still. This causes the water to boil rapidly at a much lower temperature than it would otherwise, and the steam, rushing into the condenser, is condensed along with the steam from the cylinder. The additional water thus obtained is delivered to the boiler by the action of the air-pump. See STILL.

*a* is the steam-cylinder.

*b*, the steam-pipe from the boiler.

*c*, a belt or channel surrounding the cylinder and conveying the steam to the slide-valve chest *d*.

*e*, the tubes of the middle chamber *g* of the condenser.

*f*, the upper chamber of the condenser communicating with eduction steam-port.

*g*, the middle chamber, containing cold sea water and traversed by the tubes *e*.

*h*, the lower chamber of the condenser, collecting the water dropping from the tubes.

*k*, the foot-valve.

*l*, the air-pump.

*m*, the hot-well.

*n*, the snift-valve.

*o*, the float operating the snift-valve.

*p*, the feed-pipe leading to the boiler.

*q*, the cold-water pipe, placed between the valve-chest and the condenser.

*r*, the cold sea-water supply-pipe.

*s*, the apertures in the wall of the chamber *g* by which the cold water enters.

*t*, outlet passages by which the water in chamber *g* is returned to the sea.

*u*, the throttle-valve.

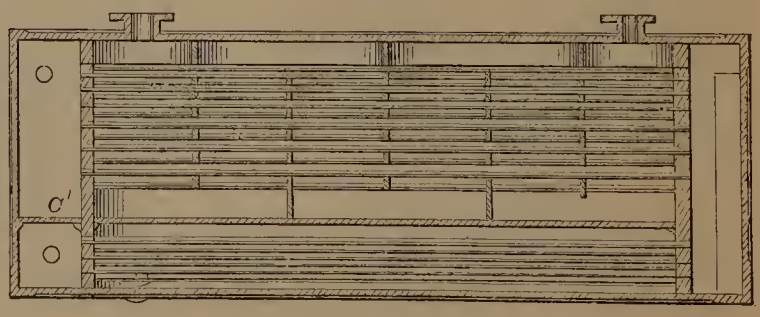
*w*, the blow-through valve.

*x*, a distributing plate in the upper chamber of the condenser.

Fig 6077 shows a form in which the steam and the water follow sinuous courses flowing in opposite directions.

In Fig. 6078, a partition *C'* is placed in the chamber in which the cooling water is received, for the purpose of compelling

Fig. 6078.



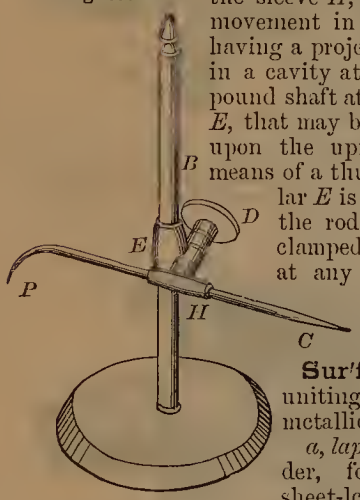

*Condenser.*

water to pass the tubes of the lower or cooling section of the condenser, and return it through the upper or condensing series of tubes; the object being to more thoroughly cool the condensed water than could be done if the cooling water entered both the condensing and cooling tubes at the same time. The induction and eduction nozzle for the steam and water and the division plates are arranged at the same end of the condenser, whereby the steam and water are each made to traverse the entire length of the instrument in opposite directions before being discharged therefrom.

2. A steam-heated apparatus consisting of pipes or chambers over which a solution is conducted in order that its watery particles may be driven off. Such is the Degrand (Derosne) condenser. (See CONDENSER.) Such also is the EVAPORATING CONE of Belgium. (See EVAPORATOR.) Useful hints on construction may be gathered from LIQUID-COOLER, BEER-COOLER; apparatuses which differ from these surface-condensers merely in the fact that a refrigerating liquid instead of steam occupies the hollow trunk.

**Sur'face-gage.** An implement for testing the accuracy of plane surfaces. In that illustrated (Fig. 6079), the pointer *P C* slides in the sleeve *H*, which is capable of movement in a vertical plane by having a projection loosely fitting in a cavity at the end of a compound shaft attached to the collar *E*, that may be raised or lowered upon the upright rod *B*. By means of a thumbscrew *D* the collar *E* is tightly held against the rod *B*, and the pointer clamped in the sleeve *H*, at any positions to which they may have been previously adjusted.

Fig. 6079.




*Surface-Gage.*

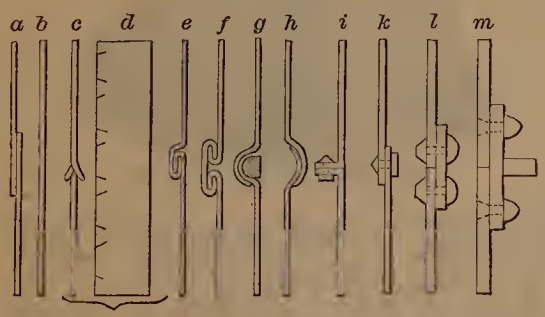
**Sur'face-joint.** A joint uniting the ends or edges of metallic sheets or plates.

*a*, *lap*-joint, with solder, for tin plates, sheet-lead, etc.

*b*, *butt*-joint, for sheet-metal plates and tubes.

*c d*, *cramp*-joint, for thin works requiring strength. The edges are thinned with the hammer, one being left plain and the other notched, forming the cramps; these are bent alternately up and down, and the plain

Fig. 6080.




*Surface-Joints.*

edge of the other sheet inserted, after which they are hammered down and brazed, when the joint may be made smooth with the hammer and file.

*e*, *lap*-joint, without solder, used for works not requiring to be steam or water tight.

*f*, sometimes called the *patent strip overlap*, avoids the double bend of the preceding joint; used for zinc, etc.

*g*, *roll*-joint, for lead roofs; the metal is folded over a wooden rib, and is not soldered; a somewhat similar joint, though the two plates do not extend over the roll, is employed for zinc, in which case the top is protected by a strip nailed to the wood.

*h* is a hollow crease used in vessels for making sulphuric acid; the crease is filled with lead, which is united to the edges of the sheets by means of a red-hot iron.

*i* is a flange-joint for pipes; the flanges are secured to each other by bolts.

*k* is a lapped and bolted joint employed in boilers and tubes.

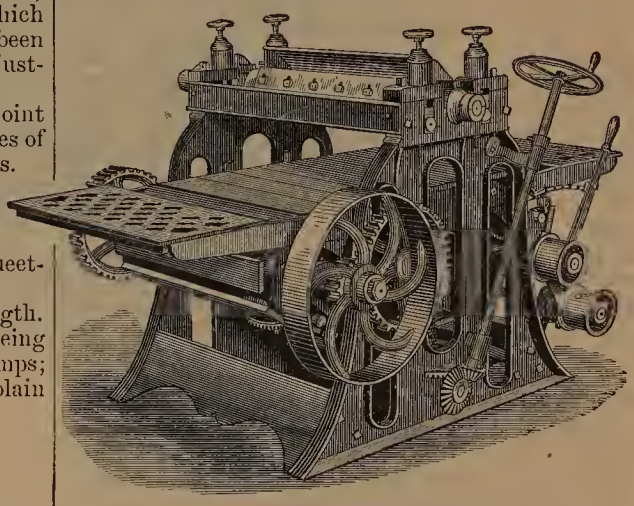
*l*, with rivets, is the common mode of uniting the marine boilers and other works required to be flush externally.

*m* is a similar mode, employed in the construction of large iron steamships; the outer skin-plates *m* form a butt-joint, and are bolted to the T-shaped iron rib, which has been bent to the proper curve.

**Sur'face-plane.** (*Wood-working.*) A form of planing-machine for truing and smoothing the surface of an object run beneath the rotary cutter on the bed of the planer.

The illustration shows a surface-planing machine with a traveling bed, on which the stuff is carried beneath the cylinder, which has three cutters. The front roll has independent weights. The machines will plane $\frac{1}{8}$ inch to 10 inches in thickness, and 24 to 30 inches width, according to size of machine.

Fig. 6081.



*Rotary-Bed Surface-Planer.*

The bed-rail is gibbed on the frame, and is raised or lowered by screws according to the thickness of the work.

**Sur'face-print'ing.** Printing from an inked surface in contradistinction to the plate-printing process, in which the lines are filled with ink, the surface cleaned, and the ink absorbed from the lines by pressure upon the plate. See COPPERPLATE-PRINTING.

The latter is universally adopted by the bank-notes of the United States, except some of the minor details, which are put on by a surface-printing.

The Bank of England notes, since January 1, 1855, have all been surface-printed.

Books, newspapers, woodcuts, and lithographs are all surface-printed. See BANK-NOTE ENGRAVING; STEEL-PLATE ENGRAVING.

Plate LXVII. illustrates several features of *en-*

*graving*, as well as affording a specimen of *surface-printing*.

The interior is a medallion head of Commodore Perry, engraved on a peculiar form of medallion-machine invented and made by G. W. Casilear of the United States Treasury Department, adapted to give several series of lines, thereby forming a network.

The usual form of medallion-machine is cited on pages 1417, 1418, and need not be re-described. Speaking in the most general terms, a tracer is made to follow the contour of the relief on the medal, and governs the motions of the diamond scriber which moves over the plate to be engraved, the ascents and descents of the tracer resolving themselves into deviations from the straight line on the engraved plate, the tracer and scriber being connected, and moved simultaneously over their respective surfaces, and being set forward a given and equal distance between each stroke.

In Casilear and Smith's medallion ruling-machine, for ruling two or more lines, there are two right-angle slides crossing at 22½°, each slide with a screw and index, to give the proper width of line to the ruling. The medallion and plate to be ruled are placed on the table of the top slide; in ruling the cross lines, the movement is given either at the angles of 22½°, 45°, or 67½°. The selection of the angle determines the form of mesh of the network produced, whether square or lozenge. The portrait (Plate LXVII.) is the production of this machine.

The border around the portrait is the production of the rose-engine, or geometric lathe, described on pages 1983, 1984, and 963. The action of the cutting-tool in the rose-engine is to make lines the product of a combination of motions of the bed-plate, and the possible variations are almost infinite. Plate LXIV., STEEL-ENGRAVING, shows a number of specimens of its work: the ornamental panel behind the letters "Washington"; the oval immediately above the work on the upright sides of the border. Plate LXIV. is printed, not as a *surface*-plate, but in the manner usual with steel-plates, by filling the lines with ink, cleaning and polishing the surface of the plate, and then laying the paper upon it and passing both through the press (Fig. 1445), when the paper absorbs the ink from the lines of the plate.

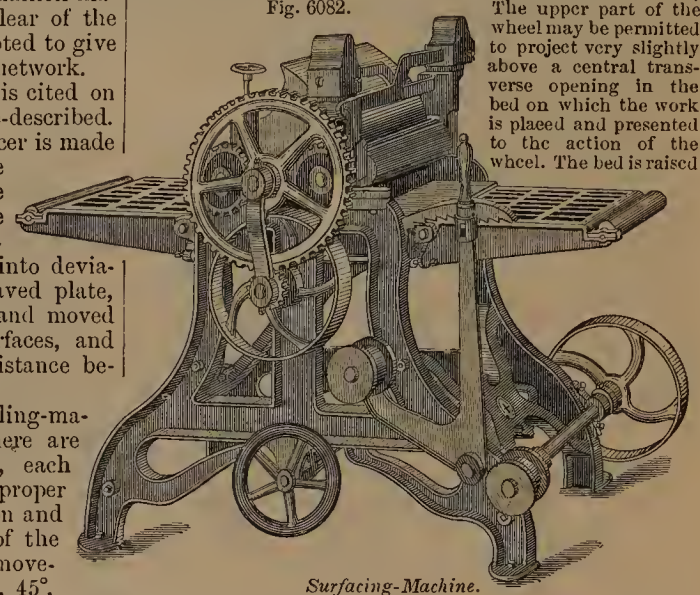
The rose-engine work around the portrait, if printed from by the surface-process directly as it was engraved, would give a black surface with a fine tracery of white lines; but, to adapt it to show its fine lines colored on a white ground, a counterpart impression in steel must be made, in which the lines are salient, not depressed, and this by transfers is made so to appear in the plate, that by printing the portrait and its border in a single operation of *surface-printing*, we have the *portrait* white-line work on a dark ground, and the *border* dark-line work on a white ground.

The author is indebted for this unique specimen to G. W. Casilear.

**Sur'face-roll'er.** (*Calico-printing.*) The engraved cylinder used in calico-printing.

**Sur'fac-ing-ma-chine'.** 1. (*Wood-working.*) A machine for planing timber. The piece is fed by weighted corrugated feed-rolls to rotary cutters, which smooth its surface; bearing rollers at each end of the machine steady and equalize the motion of the piece (Fig. 6082).

Fig. 6082.



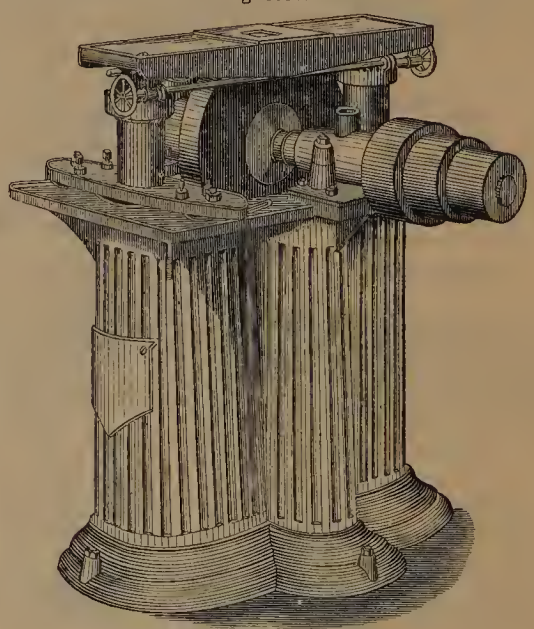
*Surfacing-Machine.*

The belt of the driving-pulley is thrown in or out of action by a tension-roller connected with a hand-lever manipulated by the operator. The table or platen may be raised or lowered by two screws gearing with a cross-shaft operated by a hand-wheel.

2. (*Metal-working.*)

The machine (Fig. 6083) is designed for finishing off metallic surfaces by grinding. It is provided with a wheel faced with tanite. (See TANITE.) The upper part of the wheel may be permitted to project very slightly above a central transverse opening in the bed on which the work is placed and presented to the action of the wheel. The bed is raised or lowered by means of two worms which engage worm-wheels at the upper ends of two screw-standards entering circular openings at either end of the compound pillar which forms the base of the machine.

Fig. 6083.



*Emery-Wheel Surfacing-Machine.*

**Surf-boat.** A peculiarly constructed boat for landing or pushing off through the surf. See CATAMARAN; LIFE-BOAT; MASSOOLAH-BOAT.

**Surge.** (*Nautical.*) The swell on a windlass-barrel upon which the cable or messenger *surges* or slips back.

**Surge-re-liev'er.** A spring interposed between an object subjected to sudden strain and a relatively immovable object or one difficult to start. Such are placed on some pulley-blocks, to prevent their being snatched away; in harness, between the trace and the wagon; in cables, to take off suddenness of the jerk upon the bitt, windlass, capstan, or cable-stopper. See patent 27,505, March 13, 1860. See also

MEDALLION HEAD OF COMMODORE PERRY

PLATE LXVII. SPECIMEN OF SURFACE PRINTING. *See pp.* 2458, 2459.

Fig. 6084.

*Surgical Appliances.*

DRAFT-SPRING; SPRING-COUPLING; etc.

**Surge-spring.** See SURGE-RELIEVER; DRAFT-SPRING; SPRING-COUPLING.

**Sur'gi-cal Ap-pli'an-ces.** (*Surgical.*) Apparatus—perhaps rather as distinct from instruments—embracing bandages, splints, apparatus for weak, deformed, luxated, or fractured limbs; shoulder and spinal braces and supporters; specific contrivances for extension and counter-extension; for deflections and local muscular and vascular relaxation. See list of SURGICAL INSTRUMENTS.

**Sur'gi-cal In'stru-ments.**

The word *surgeon*, or *chirurgeon*, is derived from the Greek χειρ and ἔργειν, signifying to work with the hand, and plainly indicative of the manipulations, topical treatment, and even palmistry. The healing art of the physician was early dissociated from that of the operative surgeon, as appears in the oath of Hippocrates, who forbade the practice of lithotomy to the physician. In a condition of things still more remote, the medicine-man was a priest, as he is to-day in Egypt, India, China, and Japan, and among savage and half-civilized peoples.

The surgeons of Egypt are the earliest of whom we have record. The *basso-rilievos* of Thebes display instruments and operations similar to those of the present. Venesection and circumcision are among the earliest mentioned. The art of embalming, as of healing, was practiced by the priests, and the physicians of note were deified both in Egypt and in Greece. Asclepias in the former, or Esculapius, in the latter, were demi-gods, the latter being reputed to be the son of Apollo, and to have accompanied Melampus and Chiron as surgeons on a warlike expedition, about 1242 B. C., fifty years before the fall of Troy. Machaon and Podalirius, two sons of Esculapius, were army surgeons with the Greeks in the Troad. Damocedes, 600 B. C., was taken prisoner by the Persians, and became court physician in Persia, reducing a dislocation of the ankle for Darius, and removing a cancer for his queen Atosa. Herophilus and Erisistratus, of Alexandria, made that school famous in the third century, B. C., and are reputed to have dissected the human body. The tourniquet, catheter, lithontriptor, and ecraseur were probably used by them. Galen practiced in Rome in the second century, A. D.

Fig 6085 shows a number of surgical instruments discovered by the Russian physician, Dr. Savenko, in 1819, in the Via Consularis, Pompeii. The instruments are in the Museum of Portici. They were discovered in a house supposed to have belonged to a surgeon. They are,—

*a b*, two probes (*specillum*) respectively six and four and a half inches long.

*c*, a cautery of iron, four inches long.

*d e*, two lancets (*scalpellum*) of copper, four and a half and three inches long.

*f*, a small copper amputating-knife, with a wavy edge. The illustration (taken from *Revue Médicale*, for 1821, Vol. III. page 427) shows it out of proportion; it is two and a half inches long, one inch broad, and has a thick back adapted to be struck by a mallet.

*g*, a scalpel, with a probe point.

*h*, an iron needle.

*i*, an elevator for raising depressed portions of the skull.

*j j k l*, different kinds of forceps; *l* is a tenaculum forceps, with a running ring.

*m*, hair tweezers.

*n*, esophagus forceps.

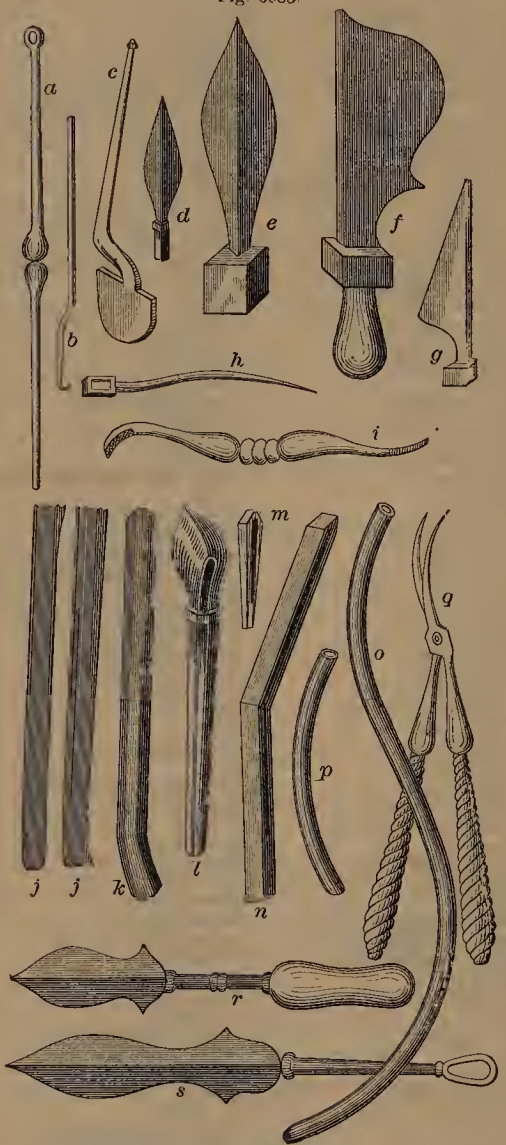
*o p*, catheters (male and female).

*q*, uvula forceps.

*r s*, spatulas.

The library of the Surgeon-General's office, Washington, D. C., has been formed since the close of the war, and now contains about 39,000 volumes, besides about 20,000 pamphlets.

Fig. 6085.




*Surgical Instruments found at Pompeii.*

It is really the National Medical Library of the United States, is catalogued and managed like the Congressional Library, and is intended for the benefit of the entire profession of the country. It is a very good practical working library, and is especially rich in periodicals.

From the priests the profession of surgery seems to have passed to the barbers, the term *barber-surgeon* being much older than that of surgeon. The fourth Lateran council, in 993, forbade the "shedding of blood" by the priests, and thus continued in force the old distinction between medicine and surgery which was enforced by Hippocrates, and is yet jealously maintained in European countries. Farther papal interference by the seventh Lateran council in 1131, and the Council of Tours in 1163, disassociated the clergy from medicine, which then fell to the apothecaries, as surgery had to the barbers, who were also keepers of the baths. French and English charters and municipal regulations show that the profession was gradually assuming systematic proportions, court and army surgeons becoming of note, the *chirurgeon* proper, who also studied medicine, gradually edging away from the mere *barber-surgeons*, who simply shampooed, bled, blistered, cupped, drew teeth, and bound up the wounds of the victims of the frequent frays. The chirurgeon proper wore a robe and cap, when, in 1572, bluff King Harry granted the Royal College of Physicians of London the power of licensing practitioners in the city of London and within seven miles thereof,—a right still extant.

The distinction between *chirurgiens* and *perruquiers* was fairly drawn by enactment in France, *temp.* Louis XIV., and in England in 1745, by act of Parliament, *temp.* George II.

**Sur'gi-cal In'stru-ments and Ap-pli'an-ces.** See under the following heads:—

Abaptiston.
Abdominal supporter.
Acanthalus.
Accipter.

Acoumeter.
Acoustic instruments.
Acupuncturator.
Acus.
Acutenaculum.
Alphonsin.
Ambe.
Amputating-knife.
Amputating-saw.
Anæsthetic refrigerator.
Anæsthetics. Instruments for applying
Anal dilator.
Anal speculum.
Anaplastic instrument.
Anchylosis-apparatus.
Ancyclomele.
Aneurism-needle.
Aneurism-tourniquet.
Aortic compressor.
Applicator.
Arm. Artificial
Arterial compressor.
Artery-claw.
Artery-forceps.
Arteryotome.
Articulator.
Artificial arm.
Artificial auricle.
Artificial ear.
Artificial eye.
Artificial foot.
Artificial gums.
Artificial hand.
Artificial leech.
Artificial leg.
Artificial limb.
Artificial nipple.
Artificial nose
Artificial palate.
Artificial pupil.
Artificial teeth.
Artificial tympanum.
Astigmatism-apparatus.
Atomizer.
Auricle. Artificial
Auriscalpum.
Auriscope.
Anto-laryngoscope.
Auto-ophthalmoscope.
Autopsy-instrument.
Baudage.
Baromacrometer.
Bath.
Bdelometer.
Bidet.
Bistoury.
Blooding-stick.
Blunt hook.
Body-supporter.
Bone-chisel.
Bone-drill.
Bone-elevator.
Bone-forceps.
Bone-scraper.
Bone-staff.
Bougie.
Breast-cup.
Breast-pump.
Branchotome.
Bullet-extractor.
Bullet-forceps.
Bullet-probe.
Bullet-scoop.
Bullet-screw.
Burial-case.
Calculi-forceps.
Calculi-instrumeuts.
Cano-trumpet.
Cannula.
Cauou.
Caponizing-instrnment.
Cardiometer.
Castrating-clamp.
Catamenial bandage.
Catamenial supporter.
Cataract-knife.
Cataract-needle.
Catarrhal syringe.
Catheter.
Catheter-gage.
Catheter-syringe.
Cathetometer.
Catling.
Canterizing instrument
Cautery.
Cauting-iron.
Cephalotome.
Cephalotribe.
Ceratome
Chain-saw.
Chaiu-saw carrier.
Chiropodic instrnments.
Chondrotome.
Cionotome.
Circular saw.
Cirsotome.
Claw. Obstetric
Clinical thermometer.
Cliseometer.
Club feet. Apparatus for
Coaptator.
Coffin.
Compress.
Compressor.
Conductor.
Congestor.
Conversation-tube.
Coreotome.
Cornet.
Coru-knife.
Corns. Instrument for removing
Corpse-preserver.
Costotome.
Couching-instrument.
Counter-exteusion apparatus.
Cradle.
Crane-bill.
Craniotome.
Cranlotomy-forceps.
Creosote appliances.
Crotchet.
Crow's-bill.
Crutch.
Cucurbitula.
Cup.
Cupping-instruments.
Cupping-pump.
Curette.
Cutisector.
Cystitome.
Cystotome.
Decantation.
Decussorinm.
Dental forceps
Dental hamuer.
Dental instruments.
Denti-scalpium.
Deodorizer.
Dermal iustruments.
Dermopathic instrument.
Diacaustic.
Dilator.
Director.
Disinfecting-apparatus.
Dislocation-apparatus.
Dissecting-forceps.
Dissecting-knife.
Dock-holder.
Dossil.
Douche.
Dropping-tube.
Ear. Artificial
Ear-cornet.
Ear instruments.
Ear of Dionysius.
Ear-speculum.
Ear-spoon.
Ear-syringe.
Ear-trumpet.
Ecrasenr.
Ectropium.
Electro-magnetic machine.
Electro-medical apparatus.
Electro-puncturing.
Elevator. Bone
Endoscope.
Endosmometer.
Enema-syringe.
Enterotome.
Entropium.
Entropium-forceps.
Esophagus-forceps.
Esthesiometer.
Eustachian-tube instrument.
Exercising-machine.
Exsecting-saw.
Exsection-apparatus.
Extensiou.
Extractor.
Eye. Artificial
Eye-cup.
Eye-extirpator.
Eye-forceps.
Eye-instruments.
Eyelid-dilator.
Eye-protector.
Eye-speculum.
Eye-syringe.
Fibula.
Firing iron.
Fissure-needle.
Fleam.
Fermentation-apparatus.
Foot. Artificial
Forceps.
Fourchette.
Fracture-apparatus.
Fracture-supporter.
Galvanic moxa.
Garrot.
Goggle.
Gonorrhea-syringe.
Gorget.
Gums. Artificial
Hamulus.
Haud. Artificial
Hearing-trumpet.
Hemadynamometer.
Hemorrhage-instrument.
Hemorrhoidal syringe.
Hernia-instrumeuts.
Hernia-supporter.
Hey's saw.
Hypodermic syringe.
Hysterometer.
Hysterotome.
Inhaler.
Injection-syringe.
Insufflator.
Invaginatorium.
Iriaskistrum.
Iridectomy-instrument.
Iridioscope.
Irritation-iustrument.
Jaw-lever.
Keratome.
Key. Dental
Kiotome.
Knife.
Labidometer.
Lachrymal-duct dilator.
Lactoscope.
Lancet.
Langate.
Laparotome.
Laryngeal ecraseur.
Laryngoscope.
Leech. Artificial
Leg Artificial
Levator
Lever. Obstetric
Ligating-forceps.
Ligature-carrier.
Ligature-tyer.
Limbs. Artificial
Lint.
Lithoclast.
Litholabe.
Litholyte.
Lithontriptor.
Lithotome.
Lithotomé caché.
Lithotomy-forceps.
Lithotomy-gorget.
Lithotomy-searcher.
Lithotomy-sound.
Lithotritor.
Locking-forceps.
Mallet. Dental
Manikiu.
Mauometer.
Masticator.
Meatuscope.
Meatus knife.
Medicator.
Medicinal cup.
Menstrual supporter.
Metacarpal saw.
Metrenchytes.
Metrometer.
Metroscope.
Metrotome.
Mierocaustic.
Milking-shield.
Mortar.
Mouth-speculum.
Moxa.
Nasal irrigator.
Nasal speculum.
Needle.
Needle-forceps.
Needle-holder and tools.
Needle. Surgical
Nerve-needle.
Neurotome.
Nipple. Artificial
Nipple-shield.
Nose. Artificial
Nursery-bottle.
Obdurator.
Obstetrical forceps.
Obstetric instruments.
Odontagra.
Ointment-syringe.
Operating-table.
Opsiometer.
Ophthalmometer.
Ophthalmoscope.
Ophthalmostate.
Opsiometer.
Organic vibrator.
Orthopœdic apparatus.
Osmometer.
Otophone.
Otoscope.
Pad for trusses.
Pedometer.
Palate. Artificial
Parallel-knife.
Paring-knife.
Paring-scissors.
Patella-apparatus.
Pelvimeter.
Penis-syringe.
Percussor.
Perforator. Obstetric
Periodoscope.
Periosteum-elevator.
Phacocystectome.
Pharyngotome.
Pile-supporter.
Pill-machine.
Pill-tile.
Placenta-forceps.
Placenta-hook.
Plaster-machine.
Plaster-spatula.
Plate for artificial teeth.
Pleximeter.
Pneumatometer.
Polypus-forceps.
Porte-aiguille.
Porte-caustic.
Porte-cordon.
Porte-meche.
Post-mortem case.
Probaug.
Probe.
Probe-syringe.
Prolapsus-instrument.
Pterygium.
Pulmometer.
Pulsometer.
Pupil. Artificial
Rachitome.
Raspatory.
Remora.
Respirator.
Retractor.
Retroversion-instrument.
Rhinoplastic knife.
Rhinoplastic pin.
Rhinoscope.
Rostrum.
Roweling-needle.
Roweling-scissors.
Rupturing forceps.
Saliva-pump.
Scalpel.
Scalper.
Scalprum.
Scarificator.
Scissors.
Scissors. Canaliculа
Scissors. Conjunctiva
Scissors. Dissecting
Scissors. Harelip
Scissors. Iridectomy
Scissors. Pterygium
Scissors. Roweling
Scissors. Strabismus
Scoliosis-brace.

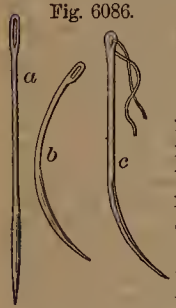
Searcher.
Searing-iron.
Segment-saw.
Serre-fin.
Serre-uœud.
Seton.
Seton-needle.
Shoulder-brace.
Solen.
Sonifier.
Sound.
Spatula.
Speculum.
Speculum-forceps.
Spermatorrhœa. Apparatus for
Spermatorrhœa-syringe.
Sphygmograph.
Sphygmometer.
Sphygmoscope.
Spinal-distortion apparatus.
Spinal supporter.
Spirometer.
Splint.
Sponge-tent.
Spoon. Medicinal
Spring for artificial teeth.
Staff.
Staphyloraphic instruments.
Steam-atomizer.
Stethometer.
Stethoscope.
Stilette.
Stomach-pump.
Stomatoscope
Strabismus-forceps.
Strabismus-scissors.
Stricture-cutter.
Stricture-dilator.
Stylet.
Subcutaneous saw.
Supporter.
Surgical needle.
Suspension-bandage.
Suture-conductor.
Suture-instrument.
Synosteotome.
Syringe.
Syringe-case.
Syringotome.
Table. Operating
Talipes-apparatus.
Talipes-instruments.
Tampon.
Tape-worm apparatus.
Tenaculum.
Tenotome.
Teut.
Testes-supporter.
Tonsilotome.
Tooth. Artificial
Tooth. Saw
Torcular.
Tourniquet.
Trachea-forceps.
Tracheotome.
Tracheotomy-tube.
Tractor. Obstetric
Transfusion-syringe.
Trepan-saw.
Trephine.
Trilable.
Trocar.
Truss.
Turnkey.
Tympanometer.
Tympanum. Artificial
Universal syringe.
Uranicoplastic instruments.
Urethra-cutter.
Urethra-syringe.
Urethratome.
Urinometer.
Utereotome.
Uterine dilator.
Uterine douche.
Uterine elevator.
Uterine redresser.
Uterine scarificator.
Uterine speculum.
Uterine-support director.
Uterine supporter.
Uvula-forceps.
Vaccinator.
Vacuum-apparatus.
Vaginal speculum.
Vaginal supporter.
Vaginal syringe.
Vaporarium.
Vapor-inhaler.
Varicose stockings.
Vectis.
Ventouse.
Xyster.

**Sur'gi-cal Knife.** See under the following heads:—

Amputating-knife.
Arteryotome.
Bistoury.
Cataract-knife.
Catling.
Costotome.
Dissecting-knife.
Double knife.
Hysterotome.
Keratome.
Lancet.
Meatus-knife.
Metrotome.
Parallel knife.
Pharyngotome.
Scalpel.
Tenotome.
Tonsilotome.
Urethratome.
Utereotome.

**Sur'gi-cal Nee'dle.** One used for sewing up wounds and cuts. They are of various shapes and sizes.

Fig. 6086.




*Surgical Needles.*

A surgical needle, of the usual bent form, was disinterred at Pompeii in 1819, in company with a variety of surgical instruments: lancets, catheters, probes, forceps (Fig. 6085).

**Sur'mark.** (*Shipbuilding.*) *a.* A mark drawn on the timbers at the intersection of the molding-edge with the ribband-line; the stations of the ribbands and harpings being marked on the timbers.

*b.* A cleat temporarily placed on the outside of a rib, to give a hold to the ribband by which, through the shores, it is supported on the slipway.

**Sur-vey'.** *a.* An examination of a tract as to extent, contour, divisions, etc.

*b.* A plan showing the said features, or some of them.

A *trigonometrical* survey is one made by triangulations, as the coast survey of the United States, the ordnance survey of England.

In a *geodetical* survey, the curvature of the earth is taken into account.

*Maritime* or *nautical* surveying concerns the coast, and gives bearing of prominent objects, positions of shoals, depths of water, etc.

*Plane* surveying does not take the curvature of the earth into account, as does *geodetic*.

*Topographical* survey deals with the positions of planes on the surface of the earth.

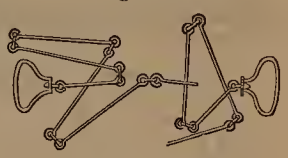
**Sur-vey'ing-in'stru-ments.** See, —

Astrolabe.
Circumferentor.
Compass-prismatic.
Geometric square.
Demi-circle.
Jacob-staff.
Level.
Leveling-staff.
Object-staff.
Odometer.
Optical square.
Plane-table.
Sector.
Sextant.
Station-pointer.
Surveying-cross.
Surveyor's chain.
Theodolite.

**Sur-vey'or's-chain.** This chain, called *Gunter's*, after the name of the person who adapted it, is 4 rods or 66 feet long, made of Nos. 6 to 9 wire, and has 100 links. 10 of these square chains are equal to an acre. $66 \times 66 \times 10 = 43{,}560$ feet $= 1$ acre; or, counting by links, $100 \times 100 \times 10 = 100{,}000$ square links $= 1$ acre.

The chain is divided every 10 links by notched brass marks, so that the fractions may be readily distinguished.

Fig. 6087.



*Surveyor's-Chain.*

Chains 100 feet long, divided into 1-foot links, are also used by civil engineers.

Other apparatus is used where extreme accuracy is required.

The *decempeda*, or 10-foot pole, was the standard land-measure of Rome.

The base line for the trigonometrical survey of Great Britain was laid down by General Roy on Hounslow Heath, and is 5.2 miles long, nearly. It was measured at first with pine rods; but as these were found to be affected by the hygrometrical changes of the atmosphere, it was again measured with glass tubes 20 feet in length, furnished with a peculiar apparatus for making the contacts. In the subsequent measurement of the same line for the Ordnance Survey, two steel chains of 100 feet in length, and made by Ramsden, were employed. One of these was kept as a measuring-chain; the other was kept for the purpose of comparing the measuring-chain with it before and after the operation. In the act of measuring, the chain was laid in a trough supported on trestles, and was stretched with a weight of 56 pounds. The same apparatus was employed in measuring five other bases in different parts of the country, for the purpose of verifying the accuracy of the work.

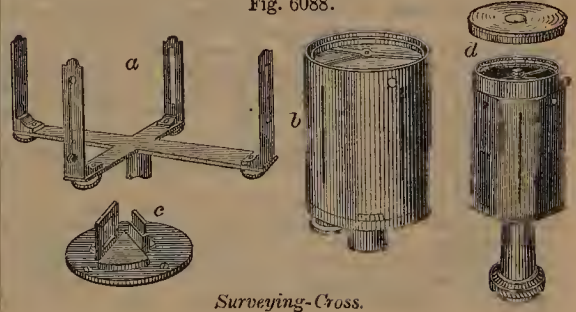
For the measurement of the Lough Foyle base in the survey of Ireland, nearly 8 miles in length, Colonel Colby employed a compensating apparatus formed of bars of different metals, so arranged that the distance between the two points viewed by compensation microscopes remains constant under all changes of temperature. For account of measurements of degrees of latitude, see ODOMETER.

"The method of triangulation in a great survey, by means of quadrilaterals, is purely American in its origin, having been first introduced by the late Professor Bache." — PROF. PEIRCE.

**Sur-vey'or's-com'pass.** The measuring-compass was invented by Jost Bing of Hesse, in 1602. See CIRCUMFERENTOR; THEODOLITE.

**Sur-vey'or's-cross.** An instrument employed for establishing perpendicular lines in surveying. It has four sights fixed at right angles upon a brass

Fig. 6088.




*Surveying-Cross.*

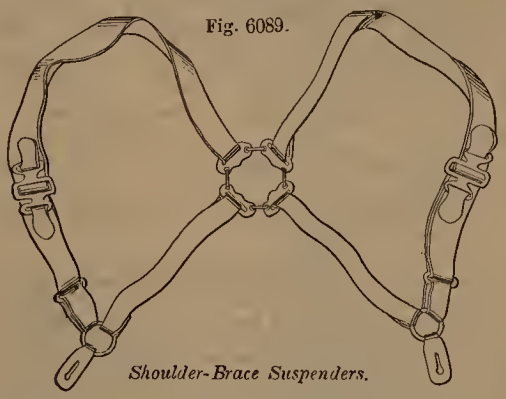
cross, which can be screwed to a tripod or single staff. The instrument is adjusted so that one pair of sights coincide with a given or base line, when a line perpendicular to the former can be easily observed, traced, or set out by viewing through the other pair of sights (*a*, Fig. 6088).

A cylindrical or octagonal box of brass, called the *optical square*, *b d*, is used for the same purpose as the instrument with four sights on the brass cross. The box has four vertical slits answering to the four sights just mentioned, and inside the box are the two principal glasses of the sextant, the index and horizon glasses, placed at an angle of 45° (*c*, Fig 6088), so that, when viewing an object by direct vision, any other forming a right angle with it at the place of the observer will be seen by reflection to coincide with the object viewed. Placing the instrument in such a position as to look along any given line, the surveyor is enabled to direct the planting of a station-staff at right angles thereto. Some of these instruments are made small enough to be carried in the pocket.

**Sus-pend'er.** A strap or pair of crossed straps over the shoulders to hold up the trousers. They usually have bifurcated ends in front and single ends behind, fastening to four buttons in front and two behind.

The example uses but two buttons, and those on the sides. The suspenders are so formed that the strain shall act on a common center, and also serve as a brace to the shoulders.

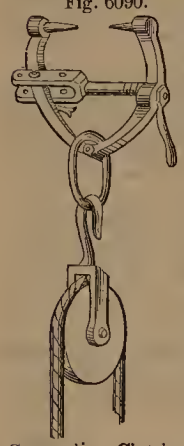
Fig. 6089.



*Shoulder-Brace Suspenders.*

**Sus-pend'ing-clutch.** A grapple to be fixed to a beam in a barn or warehouse, for the purpose of suspending hoisting-tackle.

Fig. 6090.



*Suspending-Clutch.*

**Sus-pen'sion-bridge.** A bridge sustained by flexible supports secured at each extremity.

Suspension-bridges have been used from a period of great antiquity in China, Thibet, and South America. Turner, in his "Voyage to Thibet," gives an account of one at Tchin-chien, near the fort of Chuka, about 140 feet long, and which afforded passage for equestrians. It was supported by five chains, covered with pieces of bamboo. These bridges have also been mentioned by old travelers in China.

A bridge over a river in the province of Yunnan, China, is said to have been first built 2,000 years ago. A much larger one, spanning the river Pei, was built during the Ming dynasty. It consists of a number of chains stretched across the river and secured to the rock on each side; these are stayed and strengthened by other chains attached at various parts of the span and fastened to points above and below, to prevent swaying. A plank-floor is laid on the chains, and is repaired at intervals of three to five years by the Imperial government. Its span is said to be several hundred feet. One of this kind, mentioned by Kirchen, is 330 feet long, and is said to have been built A. D. 65.

Bamboo-bridges exist in Japan. One over the Fujikaira River is stated to be about 100 feet above the river; its span being 60 and width 4 feet.

Humboldt refers to the bridges of ropes used by the native Americans, and called *cimppacha*, from *cimppa*, ropes: and *chaca*, a bridge. The ropes of one, referred to by this distinguished German, were 3 or 4 inches in diameter, and made from the fibrous roots of the American agave. They are anchored by fastening on the shore to the trunks of trees, and the track is formed of bamboos laid transversely. They are subject to dangerous lateral swaying, and Humboldt advises to cross them on a run, keeping the body well forward, and in single file. He says that a guide and traveler walking at different rates, especially if the latter stop and grasp the balustrade-ropes, will throw the bridge into convulsions.

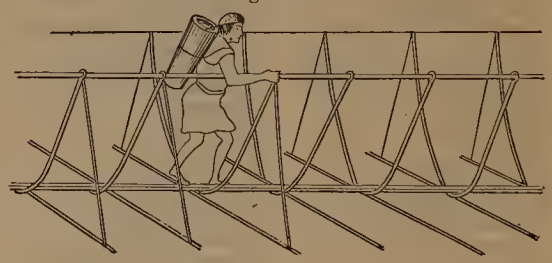
The road between Quito and Lima crosses a deep ravine by a rope bridge, which affords passage for loaded mules.

These bridges are said to last from 20 to 25 years, and break before they are renewed in that rather supine country.

A bridge was erected about 40 years since at Aligpore, in Hindostan, 130 feet in length and 5 in width, the cables being of cane, with iron fastenings. The canes are obtained on the north-east frontier, and are from 100 to 225 feet in length, and from 1 to nearly 2 inches in diameter. They are coiled like ropes for transportation, and 18 canes are lashed together to support the track of transverse bamboos which are lashed to the canes. Guys to the banks, above and below, steady the bridge against lateral deflection.

The accompanying cut shows the structure of a bridge 240 feet long, and 40 feet above the waters of the Runject, near Dorjiling, in the Himalaya. Two parallel canes are suspended

Fig. 6091.



*Cane-Bridge, Nepal, India.*

between a fig-tree on one side of the stream and strong posts on the other side. From these canes are suspended loops in which are the canes forming the floor, and the proper relations of the parts is maintained by cross-ties, which stretch apart the suspension-canes, which are formed by a species of rattan, 20 or 30 yards long, and knotted together, the other pieces being fastened together by strips of the same plant.

Several suspension-bridges, formed of iron chains supporting loops on which planking is laid, are mentioned by Hooker in his "Himalaya Journals." One crossed the Mywa, a western affluent of the Tambur in Nepal; another the Newa, in which the chains were clamped to the rocks on either shore, and the suspended loops encurred at intervals of 8 or 10 feet.

Suspension-bridges in Europe are mentioned by Seamozzis in his "Del Idea Archi," 1615.

The principles of their construction were laid down by Bernouilli (born at Bâle, Switzerland, 1654; died in same city, 1705).

The first chain-bridge in England appears to have been laid across the river Tees about the year 1741; its length was 70 feet, and breadth rather more than two; it was a mere foot-bridge, and seems to have been a very rude affair. Finlay constructed a chain-bridge in this country in 1796, over Jacob's Creek, between Uniontown and Greensburg, Pa., taking out a patent in 1801; in 1811 eight bridges had been built on his plan, which does not seem, however, to have recommended itself to the public generally, as we hear no more of it after that date. In 1819 a bridge, supported by cables, was constructed across the Tweed at Berwick, Eng., by Sir Samuel Brown; it had 449 feet span. Telford's bridge, over the Menai strait, was finished in 1826. It was suspended by rods of iron, 5 in a set, 4 of these constituting a link of the chain; these were connected by bolts and chain-plates. The entire length of the chain was 1,710 feet, weight 3,876,784 pounds. (See plate at TUBULAR BRIDGE.) The distance between the centers of the pyramids at each end was 579 feet 10 inches; the deflection of the chains in the middle 43 feet; and the hight of the roadway above high-water mark 102 feet. It was calculated to bear a burden of 732 tons, in addition to its own weight, without injury. The bridge at Fribourg in Switzerland was opened for travel, August 23, 1834; its span from pier to pier is 880 feet, and hight above the water 167 feet. It is supported by four iron wire cables, each consisting of 1,056 wires, and cost about $ 125,000 15 pieces of artillery, drawn by 50 horses, and accompanied by 300 people, were crowded together as closely as possible, first at the center, and then at each extremity, causing a depression of 39⅓ inches, but no sensible oscillation was experienced.

The Roebling Niagara suspension railway-bridge has a span of 821 feet; it is suspended by wire cables, and stiffened by timber trussing, containing between the abutments 600 tons of wood and 400 tons of iron. The passage of an ordinary train, estimated to weigh 80 tons, caused a deflection of .41 foot, of which Mr. Barlow computed .182 foot was due to the elongation of the cables (*a*, Fig. 6093).

This bridge has two floors, one 19 feet above the other, leaving a clear space of 15 feet between them. The lower one is used for ordinary purposes, while the upper one is laid with a

Fig. 6092.

*Niagara Suspension-Bridge, from the Top of the Bank on the Canadian Side.*

railway-track and provided with footpaths; the flooring of this is 245 feet above the surface of the water. Two cables support each roadway, making four in all, which are mutually connected, so that the strain of a load is distributed among the whole. These are 10¼ inches in diameter, composed of 7 strands of 520 wires each, every wire being calculated to bear a strain of 1,648 lbs., or 12,000 tons in all.

The upper cables are brought, by means of braces, to within a distance of 13 feet from each other at their centers, and the suspenders inclined inward, so as to give a broader base to the structure and assist in assuring its stability.

Instead of a pier at each end, a separate tower is provided for each pair of cables, thus greatly reducing the amount and cost of the masonry.

The upper and lower floors are connected by wooden posts arranged in pairs, and having between them sufficient room for the passage of diagonal truss-rods of wrought-iron 1 inch in diameter, passing from the top of one pair of posts to the bottom of the fourth pair from it, and distributing the pressure, the posts being 5 feet apart, over a space of 20 feet on each side; these have screw threads and nuts on their ends, so as to be capable of being screwed up in case of shrinkage of the timber. There are also a number of diagonal wire stays extending from the top of each tower, and intended to prevent vertical oscillation. Smaller stays attached to the under side of the bridge are anchored to the rocks below.

The new bridge, near to the Niagara Falls, is designed for carriages and foot-passengers. On the United States side, the towers are within a few hundred feet of the falls. In length it exceeds the lower bridge 450 feet, being 1,250 feet in the span. The towers are 105 feet high, and are built in pairs 13½ feet apart. Unlike the heavy stone columns of the lower bridge, they are light wooden trestles, 28 feet square at the base and tapering to the top. They are roofed and weatherboarded.

The bridge is sustained by two cables, which were swung in the winter of 1867-68, when the ice filled the river below the falls. The lower bridge is sustained by four cables, the upper one by two, each of which is composed of seven strands of twisted steel wire, each strand measuring 2⅜ inches in diameter, which together form a cable about 9 inches thick.

The dimensions of the bridge are: The span from rock to rock is 1,190 feet. The span between the centers of the towers is 1,268 feet. The length of the suspended platform is 1,240 feet. Hight above the surface of the river, 190 feet. The length of the central portion of the platform resting on cables is 635 feet. The deflection of cables at center causes a rise and fall of the bridge from changes in temperature of 3 feet. The length of the cables between the points of suspension is 1,286 feet; length of the cables between anchorages is 1,828 feet. Length of cables and anchors, 1,888 feet. Hight of towers above rock on Canada side 105 feet, and on American side 100 feet. Base of towers, 28 feet square, and top 4 feet square.

The width of the roadway between the parapets is 10 feet. The bridge is supported by two cables, composed of two wire ropes each, which contain respectively 133 No. 9 wires, of 9 pounds to the linear foot; the diameter of the cable is 7 inches. The total weight of the suspended portion of the cables is 82 tons net. The aggregate breaking strain of the cable is 1,680 tons net, and that of the stays 1,320 tons net, making the total supporting strength of the cables and stays 3,000 tons. The number of suspenders is 480, with an aggregate strength of 4,800 tons. The weight of the suspended roadway, including weight of cables and stays, is 250 tons. The ordinary working load is 50 tons, and the maximum load is 100 tons; permanent and transitory load, 350 tons (*d*, Fig. 6093).

The first bridge over the Ohio was the suspension-bridge at Wheeling, erected by Ellet, in 1848; this was blown down in 1854; it had a span of 1,010 feet.

The present Wheeling bridge is 21 feet 8 inches lower at the Bridgeport, O., end than at the Wheeling, West Va., end.

The Nashville, Tenn., bridge has a similar inequality.

The suspension-bridge over the Cumberland, at Nashville, has a span of 650 feet; the roadway being 22 feet 8 inches wide, consisting of a carriage-way, with a foot-path on each side. It is supported upon two cables, each 8 inches in diameter.

The Cincinnati suspension-bridge was built by John A. Roebling of Trenton, N. J., who has constructed so many others on the suspension principle. The piers are of stone, 200 feet high, and 86 by 52 feet at the base, containing 32,000 perches of masonry. Roadways of massive stone-work, arched part of the way, form the approaches to the bridge at each termination, and constitute the shore supports for the cables, which are anchored far below the ground surface and the ends of these abutments. Each of these contains 13,000 perches of stone, which, added to the 64,000 perches contained in the two towers, gives a total of 90,000 perches of stone-work in the bridge. The distance from abutment to pier is 281 feet; that of the main span across the channel-way of the river is 1,057 feet, the total length of the roadway being 2,252 feet, with a width of 36 and hight above low water of 100 feet (*c*, Fig. 6093).

The bridge is suspended from two cables, each composed of seven strands, each strand containing 740 wires, ⅛ inch in thickness, each wire of which is computed to have a tensile strength of 1,700 lbs., the whole forming a cable of 12½ inches diameter.

Imbedded nearly fifty feet below the surface, under each side of both abutments, are the large, square cast-iron plates to which are fastened the anchor-bars connecting these plates with the shoes at the ends of the cables. These anchor-bars are 10 feet long, 9 inches wide, and 1¼ inches thick, laid in rows of sixteen, side by side, in eight or nine lengths, and connected to each other, and to the shoes and anchor-plates by sockets and cross-bars.

The total cost of the bridge is estimated at $ 1,750,000.

The cables pass through grooves in saddles, supported by iron plates imbedded in the tops of the piers, and having rollers beneath them so as to allow a slight motion to the plates.

The bridge-way is suspended from the cables by suspenders, placed at distances of five feet on each side, the center ones being 1¾-inch iron rods, and those toward the ends 1⅝-inch wire ropes, attached to iron straps passing around the cable.

The roadway is of wood, having a carriage-way in the center and foot-paths at each side.

The bridge over the East River, now in progress, connecting the cities of New York and Brooklyn, is to have a total length of about 5,862 feet from the foot of Chatham Street in New York to the corner of Main and Fulton Streets in Brooklyn. The foundations for the piers on each side are obtained by sinking caissons in the river, near the shore, and excavating until the solid rock is reached. (See CAISSON.) The towers will be 280 feet high; the clear span between them 1,600 feet. The cables are, however, to be carried back 1,337 feet on the New York side, and 837 feet on the Brooklyn side, and anchored in solid walls: their total length will thus be 3,794 feet. They are four in number, each composed of parallel steel wires, forming a bundle nearly one foot in diameter, and, besides being anchored at the ends, are supported by stays from the tops of the piers. The bases of the piers at the water line will be 134 feet long and 56 feet wide; their dimensions at top 120 × 40 feet. Two arches in each, 32 feet wide, afford entrance to the bridge; these are designed to be 120 feet in hight. The piers will be of granite, and hollow, each containing over 900,000 cubic feet of stone, and weighing over 70,000 tons (*c*, Fig. 6093. See also FRONTISPIECE to Vol. I.).

The anchorages will be masses of stone 129 × 119 feet at bottom, and 117 × 104 at top, and carried up to a hight of 89 feet above the river. The cables will enter the masonry at an

elevation of 82 feet, and, after passing 25 feet into the wall, will be connected with the chains. These consist of cast-steel bars, 13 feet long, 10 inches wide, and 1½ inches thick, arranged in ten sections, each containing 19 bars, forming four curved lines, extending from the cables to the anchor-plates, and connected by cast-steel pins six inches thick.

The four anchor-plates are located at the base of the masonry; they are cast-iron plates, with radial arms, and weigh about 25 tons each The anchor-walls have each two interior spaces 80 × 20 feet, divided into six stories, serving for warehouses above and an underground-railway passage on the lower story.

The roadway of the bridge will be 130 feet above high water, and 80 feet in width. It is proposed to have upon it two lines of track for passenger-cars, to be drawn back and forth at a high rate of speed, by a stationary engine on the Brooklyn side. The weight of the bridge is calculated at 3,483 tons; the maximum weight which could possibly be put upon it at 1,270 tons, and the average about 400 tons; the strain required to break the four cables, nearly 60 000 tons.

The cost is estimated at $6,675,000.

In Fig. 6093, the bridges represented are drawn to the same scale.

*a*, railway-bridge, Niagara River (1855).

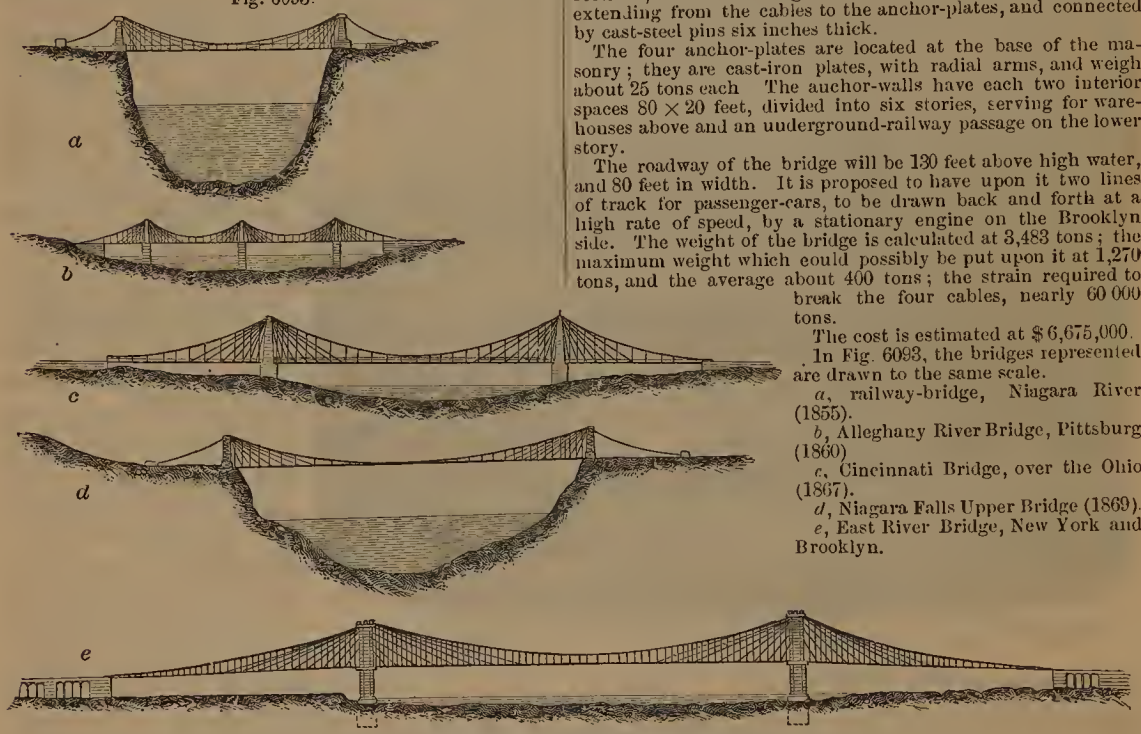
*b*, Alleghany River Bridge, Pittsburg (1860)

*c*, Cincinnati Bridge, over the Ohio (1867).

*d*, Niagara Falls Upper Bridge (1869).

*e*, East River Bridge, New York and Brooklyn.

Fig. 6093.




*Relative Spans of Suspension-Bridges in the United States.*

DIMENSIONS OF SOME OF THE PRINCIPAL SUSPENSION-BRIDGES IN THE ORDER OF THEIR LENGTH OF SPAN.

| Name. | River. | Place. | Span. | Deflection. | Date. | Engineer. |
|---|---|---|---|---|---|---|
| | | | Feet. | Feet. | | |
| New York and Brooklyn. | East River, New York. | New York and Brooklyn. | 1,600 | .. | In progress | Roebling. |
| Niagara (upper) | Niagara | Niagara Falls | 1,250 | .. | 1869 | ..... |
| Cincinnati | Ohio | Cincinnati | 1,057 | .. | .... | Roebling. |
| Wheeling | Ohio | Wheeling | 1,010 | .. | 1848 | Ellet. |
| Fribourg | Sariue | Fribourg | 870 | 63 | 1834 | Chaley. |
| Niagara | Niagara | Niagara River | 821 4 | 75 | 1848 | Roebling. |
| Clifton | Avon | Somersetshire, England | 702 | .. | 1864 | ..... |
| Charing Cross | Thames | London, England | 676.5 | 50 | 1845 | I. K. Brunel. |
| ..... | Danube | Pesth | 666 | 45 | 1850 | Clarke. |
| La Roche Bernard | Vilaine | La Roche Bernard, France | 650.4 | 50 | 1846 | Leblanc. |
| Nashville | Cumberland | Nashville, Tenn | 650 | .. | .... | Foster. |
| Menai | Menai Straits | Wales | 570 | 43 | 1826 | Telford. |
| Union | Tweed | Great Britain | 449 | 30 | 1820 | Sir S. Brown. |
| Montrose | Este | Scotland | 432 | 42 | 1829 | Sir S. Brown. |
| Hammersmith | Thames | London, England | 422 25 | 29 5 | 1824 | Tierney Clarke. |
| Albert * | Thames | Chelsea, England | 400 | .. | .... | ..... |
| ..... | Danube | Vienna | 334 | 21.4 | 1828 | Von Mitis. |
| Conway | Arm of the sea | Wales | 327 | 22 33 | 1826 | Telford. |
| Chain Pier | .. | Brighton, England | 255 | 18 | 1823 | Sir S. Brown. |
| Invalides | Seine | Paris | 236 5 | 26 33 | 1829 | Navier. |
| ..... | ..... | Isle of Bourbon | 220 3 | 25.48 | 1823 | Brunel. |
| ..... | Dnieper | Kieff, Russia | 7 spans. | Total length, 2,562 feet.† | | |

* 3 spans; 150, 400, 150. † Plate IX., page 519.

**Sus-pen'sion-drill.** (*Metal-working.*) A vertical drilling-machine having a frame which may be bolted to the ceiling, so as to be out of the way. Useful in locomotive and boiler work, etc.

**Sus-pen'sion-hook.** A portable hook to enable articles to be conveniently suspended from a nail.

In the example, a curved and a flat-bottomed hook are connected by a swivel, so that either can be turned down to suit the article to be suspended.

**Sus-pen'sion-rail'way.** A railway in which the carriage is suspended from an elevated track, one carriage on each side of a single track, so as to balance; or suspended between two tracks.

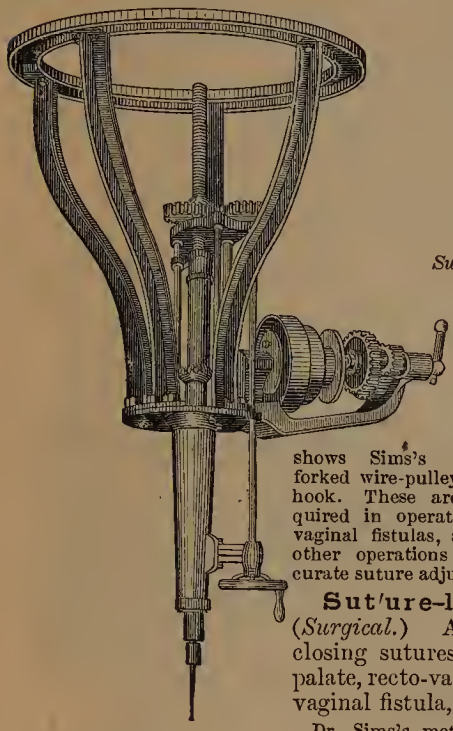
Patents representing each of these forms were taken out in England from 1821 to 1825. See ELEVATED RAILWAY; WIRE-WAY.

**Sus-pen'sion-scale.** One swung by pendent rods from levers above, in contradistinction to the usual platform-scales, whose levers are beneath. In the former case, the rod to the steelyard-lever comes from above; in the latter, it comes upward from the pit beneath. See also WEIGHING-SCALE.

**Sus-pen'so-ry Band'age.** A bag attached to a strap or belt, and used to support the scrotum, that the weight of the testes may not draw upon the spermatic cord.

**Sut'ure-in'stru-ments.** (*Surgical.*) Instruments employed for guiding and securing the wires

Fig. 6094.



*Suspension-Drill.*

Fig. 6095.

*Suspension-Hook.*

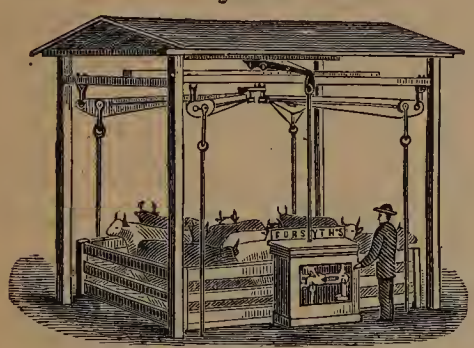
employed for holding together the edges of an incision.

Fig. 6097 shows Sims's wire-adjuster, forked wire-pulley, and a blunt hook. These are specially required in operations on vesico-vaginal fistulas, and useful in other operations requiring accurate suture adjustments.

**Sut'ure-lig'a-ture.** (*Surgical.*) A device for closing sutures, as in cleft-palate, recto-vaginal, vesico-vaginal fistula, etc.

Dr. Sims's method is as follows: The thread is passed through both sides of the incision; the two ends are brought out together, passed through a small hole in a *shot* (say size No. 1); the shot is then seized with a pair of strong forceps and pushed up the ligature until it comes in close contact with the incised edges, bringing them

Fig. 6096.



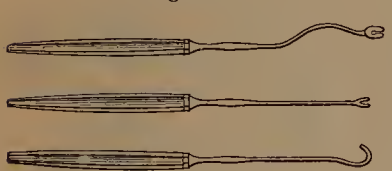
*Forsyth Suspension Wagon-Scale.*

in apposition or contact. The shot is then squeezed or pressed flat by the forceps, so that the suture is held tight. See also STAPHYLORAPHIC INSTRUMENTS.

See Dunglison's "Dictionary" for instances of capital operations in ligating.

**Sut'ure-nee'dle.** Fig. 6098 shows three of several different sizes; straight and more or less curved.

Fig. 6097.

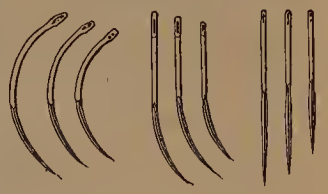


*Suture-Instruments.*

**Sut'ure-pin Con-duct'or.** (*Surgical.*) An instrument for guiding a pin or wire employed for holding together the edges of a wound, particularly in operations on the lips and face, where it is specially desirable to avoid leaving a conspicuous scar.

It consists of a slightly curved needle fixed in a handle, and somewhat eularged for a half-inch near its point. Its extremity is beveled off to a sharp point and perforated on the concave side. The edges of the wound having been brought together, the needle is passed through them with one band, and the pin or a soft iron or silver wire is engaged by its point in the perforation at the end of the conductor, and held there while the conductor is withdrawn, thus compelling the pin to follow the course of the couductor.

Fig. 6098.

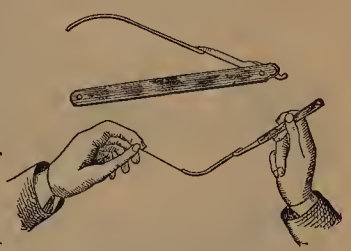


*Suture-Needles.*

**Swab.** 1. (*Nautical.*) A bundle of yarns used as a mop upon the decks.

2. (*Founding.*) A soft brush made of some strands of gasket tied together at one end and beaten and combed out at the other. It is used by the molder to wet the parting edge before *drawing* the pattern, and also to moisten parts of the mold requiring repairs.

Fig. 6099.

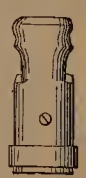


*Suture-Pin Conductor.*

3. (*Surgical.*) A pledget of lint or a spatula covered with cloth; used to clean or moisten the mouth of the sick, or cleanse a wound.

4. (*Ordnance.*) A cleaner or sponge for the bore of a gun. In the example, the disk of rubber is expanded laterally by vertical compression, and maintained in that condition by the springs which engage the shoulders of the recesses.

Fig. 6100.



*Gun-Swab.*

**Swab-pot.** (*Founding.*) An iron vessel containing water and the founder's swab.

**Swad.** (*Mining.*) A thin layer of stone or refuse coal at the bottom of the coal-seam.

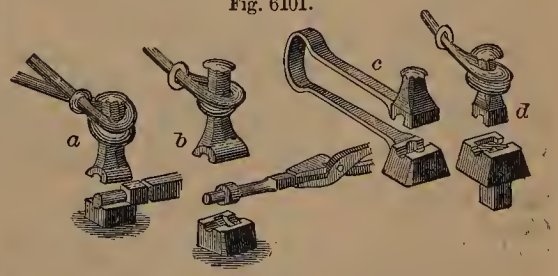
**Swage.** (*Forging.*) A tool having a face of a given shape, the counterpart of which is imparted to the object against which it is forcibly impressed.

When used by blacksmiths and other forgers in metal, it is either placed on the anvil so as to impress the hot metal, which is laid thereon and struck by a hammer or monkey; or, the work being laid on the anvil, the face of the swage is held upon it, and the back of the swage receives the blow.

Swages (and other tools), whose tangs fit into square holes in the anvil, are the *bottom tools* of the blacksmith. Those with a withe around them, operating *on* the metal and *struck* by the hammer, are *top tools;* together they form *collar-tools*, or *collar-swages* (*a b*, Fig. 6101).

*c* is a spring-swage; *d*, a *guide-swage*.

Fig. 6101.



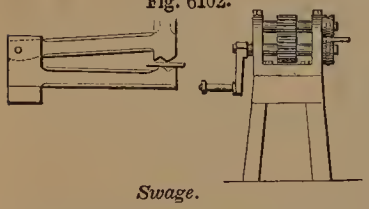

*Swages.*

Long swages are used in rounding and welding gun-barrels and other wrought-iron tubing.

Other swages operate in drop or lever presses upon sheet-metal; forming the *struck-up* tinware, such as pie-pans, lids for vessels, and a great variety of domestic and ornamental articles.

Swages of various ornate forms are used by jewelers in drop-presses for making links of chains, jewelry, etc., especially that cheap kind which is made of hollow plates soldered at the edges, and sometimes filled with a cheap metal.

Fig. 6102.

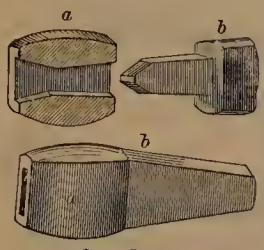


*Swage.*

Fig. 6102 shows a swage for raising beads on the edges of sheet-metal. The tail is held in the jaws of a vice; the upper jaw of the swage is pivoted, and is struck with a hammer while the metal is drawn beneath it.

The other figure is a device for effecting the same result in a neater and more expeditious manner. The metal is drawn between two grooved rolls; one is turned by a crank, and has a gear-wheel on its shaft meshing with a second wheel on the shaft of the other.

Fig. 6103.




*Saw-Swage.*

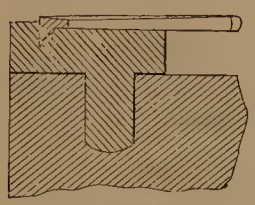
The device, Fig 6103, is used for spreading the teeth of saws. The tooth is inserted into one side of the splayed aperture through the block *a*; the other side serves as a guide to the swage *b*, which, while the saw is firmly held, is struck with a mallet, spreading and turning up the point of the tooth and enabling it to bite into the wood more readily.

Fig. 6104 is a swage for making calks on horseshoes. The upper side is struck by a hammer, driving the metal into the depressions.

Fig. 6105 is a swage and block for making watch-backs. The bezel is made continuous with the back by the annular rebate on the cameo-die.

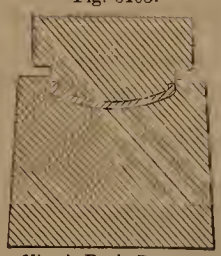
Fig. 6106 is a swage for sharpening saw-teeth. The transverse pin which passes through the end of the stock has notches or dies

Fig. 6104.



*Horseshoe-Swage.*

Fig. 6105.

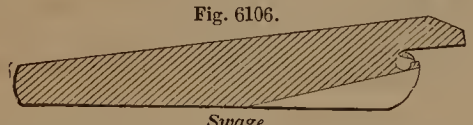


*Watch-Back Swage.*

corresponding to the width and shape of the teeth. The dies operate upon the under side and two edges of the tooth, and the projecting jaw of the stock operates upon the upper side.

Fig. 6107 is a swage for bending nozzles of milk-cans, etc.

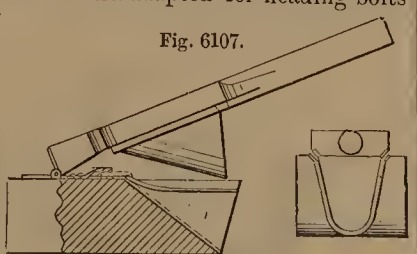
Fig. 6106.



*Swage.*

**Swage-block.** A large perforated block of iron, having grooved sides and adapted for heading bolts and swaging objects of larger size than can be worked in the ordinary heading tools and swages fitted to the anvil (Fig. 6108).

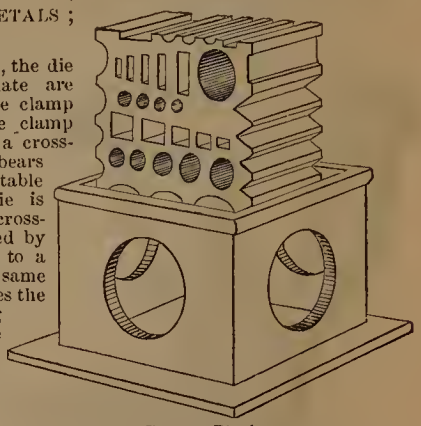
Fig. 6107.



*Die for Bending Nozzles.*

**Swag'ing-ma-chine'.** (*Metal-working.*) A machine for bringing sheet-metal to form by means of a blow or pressure in a direct line. See STAMPING-MACHINE; SPINNING-METALS; etc.

Fig. 6108.



*Swage-Block.*

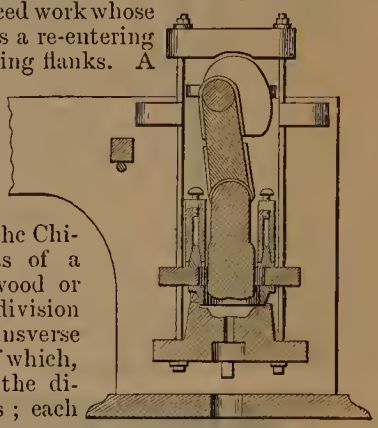
In the example, the die and its bed-plate are raised against the clamp and plunger, the clamp being secured to a cross-plate which bears against adjustable springs. The die is secured to a cross-head, reciprocated by link attachment to a crank on the same shaft which carries the eccentric giving motion to the die.

**Swal'low.** 1. (*Nautical.*) The groove around a tackle-block for the strap. Also called the *score*.

2. (*Mining.*) A cavern or opening into which water disappears.

**Swal'low-tail.** 1. (*Fortification.*) An advanced work whose salient portion has a re-entering angle and converging flanks. A *priest's cap*.

Fig. 6109.



*Swaging-Press.*

2. The points of a burgee.

**Swan-pan; Schwam-pan.** The abacus or counting-table of the Chinese. It consists of a square frame of wood or bamboo, with a division across it, and 10 transverse wires, upon each of which, above and below the division, are 5 beads; each bead representing a number (as the digits do with us), and each wire giving a particular value to the number, like units, tens, hundreds, etc.

The *yow-yow* is a smaller kind of *swan-pan*.

The abacus was the usual "reckoning-board" of the Greeks and Romans. (See ABACUS.) It is now the principal means of computation in China, Tartary, and Thibet. The Abbe Huc relates: —

Fig. 6110.

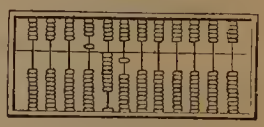
*Swallow-Tail.*

"The Thibetans, for small amounts, count on their chaplets; shopkeepers use the Chinese *swan-pan*, but the learned employ Arabic ciphers, which appear very ancient in Thibet. We [Mons. Gabet and himself] have seen Lamanesque manuscripts containing tables and astronomical calculations in this notation." They use the "5" reversed, resembling our cedilla (ç).

The adoption of the Indian numerals with *place value*, and the cipher, made the abacus unnecessary. Abbé Huc gives an amusing instance of the collision of the Arabic numeration and the *swan-pan*, at Kou-kou-kho-ton (Bluetown), in Chinese Tartary, where the Chinese merchant, in dealing with the Abbé as a supposed Tartar, had purposely made a mistake on the *swan-pan* to the extent of 1,000 sapecks, equal to 50 cents. The Abbé showed him his calculation in figures, which were utterly incomprehensible to the merchant; but a third party verifying the Abbé's computation by a correct manipulation of the *swan-pan*, the wonder became a marvel.

The Indian (Arabic) figures and numeration were introduced by Roman missionaries into the astronomical college of Pekin.

Fig. 6111.



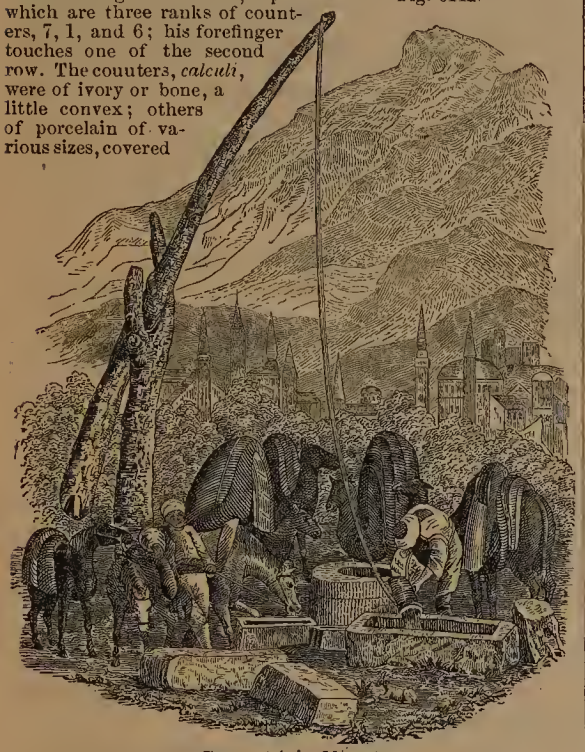
*Swan-Pan, or Chinese Abacus.*

The knotted cord was used as a means of notation in the reign of the Chinese Emperor Fuh-hi 2852 B. C. (DU HALDE.)

Hence the rosary, common in Thibet and in Europe. See ROSARY; PRAYING-MACHINE.

In addition to what is said under ABACUS (which see), it may be stated: Upon a bas-relief of the Capitol is a Trajan and a Plotina, and near them a young man holding an abacus, upon which are three ranks of counters, 7, 1, and 6; his forefinger touches one of the second row. The counters, *calculi*, were of ivory or bone, a little convex; others of porcelain of various sizes, covered

Fig. 6112.



*Swape (Asia Minor).*

with green or blue enamel, pierced, and ornamented with figures on each side. Another set are square, round, toothed, and of different sizes, some with a cross.

**Swan's-down.** (*Fabric.*) *a.* A trimming in which the fine, soft feathers of the swan and other aquatic birds are set with the quill end in the meshes of the goods, so as to make the down as a nap upon the backing of fabric.

*b.* A fine, soft, thick woolen cloth, made in imitation of *swan's-down*, a long nap being raised upon the surface.

**Swan-skin.** (*Fabric.*) A kind of fine twilled flannel.

Fig. 6113.

*Swape (Bessen, 1568).*

**Swape.** 1. The *shadûf* of the Arabs. See SHADOOF.

A bucket on the end of a line from a balanced pole which rests on a post. It has been employed for 40 centuries in Egypt; is represented on the temples and tombs of that country. The well-pole and oaken bucket are yet common in America.

The *picotah* of Hindostan is a pole and bucket suspended from the end of a balanced stage, on which a man walks to give the oscillation. See Fig. 3701.

In some form the *swape* is found in most countries where the inhabitants have recourse to wells for water.

In the form shown in Fig 6113, the pole is oscillated by a spiral bar on a vertical post, which is rotated by a horizontal water-wheel. The buckets ascend alternately, and each is emptied as it reaches the edge of the trough, the contact with which tips it and discharges the water.

2. A sconce, or light-holder.

3. A pump-handle.

4. A long oar, or *sweep.*

**Sward-cut'ter.** 1. (*Agriculture.*) A plow to turn over grass lands.

2. A mower for lawns. See LAWN-MOWER.

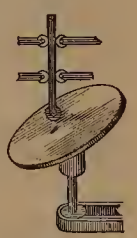
**Swarf.** Iron filings.

**Swash-bank.** (*Hydraulic Engineering.*) The crowning portion of a sea-embankment.

The lower portion is the footing, which has five base to one perpendicular. This supports the *outburst bank;* base two to perpendicular one. The *swash-bank* has the same proportions, and a level top four to five feet wide, if not required for a road. In Holland the *swash-bank* can hardly be said to exist, as the name is derived from the fact that the crest of a breaker occasionally *swashes* over. In that low country the dikes are of enormous size, more elevated than the common sea bank of other countries, and form sites for roads and canals. See DIKE; SEA-WALL.

**Swash-plate.** (*Machinery.*) A rotating, circular plate, inclined to the plane of its revolution so as to give a vertical reciprocation to the rod, whose foot rests thereupon, and which moves between lateral guides.

Fig 6114.



*Swash-Plate.*

**Swath'er.** (*Agriculture.*) A device attached to the front of a mowing-machine for the purpose of raising the uncut fallen grain and marking the line of separation between the cut and uncut grain. See Figs. 31–36, Plate XXXIII., page 1492.

**Sway-bar.** (*Vehicle.*) A bar on the hind end of the fore hounds of a wagon; the sway-bar rests on the coupling-poles and slides thereon as the wagon turns. A *slider;* a *sweep-bar.*

**Sway-brac'ing.** The guys of a suspension-bridge to prevent lateral swaying.

**Sweat'ing-bath.** A vapor-bath for sweating persons. A *stove* or *sudatory.*

**Sweat'ing-fur'nace.** (*Metallurgy.*) A liquation furnace of peculiar construction, in which a

Fig. 6115.

*Swather for Mowing-Machine.*

Fig. 6116.

*Sweating-Furnace.*

*matte* of copper and argentiferous lead is heated to deprive the copper of the metals combined therewith. The cupreous masses are placed upon the sole above the channels *f f*, which are filled with wood. The door being closed, the wood is fired, the draft being regulated by flues opening into the chimney. The argentiferous lead is separated by liquation, and the lead is oxidized, converting it into litharge, and falls to the bottom of the channels *f f*. The black copper which results is treated in a reverberatory furnace, and the argentiferous lead is cupelled.

**Sweat'ing-house.** A separate apartment, where vapor-baths are obtained.

**Sweat'ing-ir'on.** A scraper to remove sweat from horses. A similar instrument used by the

gymnasts of a former age was known as a STRIGIL (which see).

**Sweat'ing-room.** A room devoted to the use of a vapor-bath.

**Sweep.** 1. A counter-weighted pole, poised upon a fulcrum-post, and used to raise and lower a bucket suspended from the longer end. It is also written *swape*.

It is the shadûf of the Nile, and is known with us as the *well-pole* or *well-sweep*. See SHADOOF.

2. The lever of a horse-power or pug-mill.

3. (*Shipwrighting.*) The mold of a ship where she begins to compass in at the rung-heads. A part of the mold curved in the arc of a circle.

4. (*Nautical.*) *a.* A long oar used on board ship to assist the action of the rudder during a calm, or

Fig. 6117.

*Sweep.*

in an emergency; or to assist the motion of the ship, as in the ancient galley.

*b.* A circular frame on which the tiller traverses in large ships.

5. (*Founding.*) A movable templet used in loam-molding. See Fig. 3189.

6. (*Metallurgy.*) A name formerly applied to the *Almond* (*Allemand*) furnace.

**Sweep-bar.** (*Vehicle.*) A name sometimes applied to the *sway-bar* or *slider* of a wagon. See SWAY-BAR.

**Sweep'ing.** (*Nautical.*) *a.* Dragging an anchorage ground with the bight of a rope to recover an anchor, or to ascertain the position of a wreck.

*b.* Propelling a vessel by means of large oars.

**Sweep'ing-ma-chine'.** See STREET-SWEEPING MACHINE; CARPET-SWEEPING MACHINE.

**Sweep'ing-ta'ble.** (*Metallurgy.*) A form of ore-separator in which the slime, after agitation by fans in a chest with water, is flowed on to a sloping table and sorted by gravity by means of a sheet of water passing over the table. See Fig. 2096.

**Sweep-net.** One of considerable extent for drawing large areas.

**Sweep-saw.** A saw having a thin blade stretched by a frame or bow, and capable of cutting in a *sweep* or curve. (See FRAME-SAW; BAND-SAW; SCROLL-SAW.) Otherwise known as a *bow-saw*, or *turning-saw*. See also JIG-SAW.

**Sweep-wash'ings.** The refuse of shops in which gold and silver are worked. These metals are separated by mechanical means and amalgamation.

**Sweet'en-ing-cock.** (*Nautical.*) A faucet attached to a pipe passing through a ship's side, and admitting water to wash out the bilge-water passages.

**Sweet'meat.** (*Leather.*) The paint applied to leather in making what is called PATENT-LEATHER (which see).

**Sweet-po-ta'to Cul'ti-va'tor.** A form of cultivator adapted for hilling up the plants by passing each way, throwing the earth right and left.

**Swell.** 1. (*Music.*) *a.* A contrivance for giving a gradually increasing and diminishing sound to a wind-instrument by varying the volume of air which passes to the pipes or reeds.

This is accomplished by varying the size of the blast aperture, by a *knee-stop*, as in the parlor organ, or by a pedal in the church organ.

*b.* One of the three aggregated organs which are combined in an instrument of large power. The other two are the *great* organ and the *choir* organ. The key-boards form three banks; the *swell* above, the *great* organ, the *choir* organ below. The *swell* consists of an organ shut up in a box on three sides, and on the other side inclosed by *louvres*, which are opened and shut by a pedal, so as to give a *crescendo* and *diminuendo* effect. The *great* organ has the most important and powerful stops. The *choir* organ has light and solo stops.

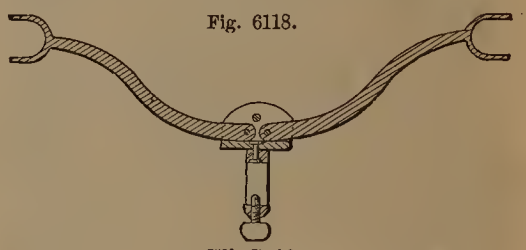
2. (*Ordnance.*) An enlargement of a gun near the muzzle. It is now suppressed in many forms of ordnance.

3. An enlarged or thickened portion of a gun-stock.

**Swift.** 1. A revolving reel with arms parallel to the axis, and affording a frame whereon to wind yarn, silk, or other thread.

*Specifically:* a hexagonal frame on which *hank-silk* is reeled, preparatory to winding on bobbins;

Fig. 6118.



*Silk-Swift.*

and from which it is unwound by the traction of the revolving bobbins.

In Fig. 6118, the swift is clamped to the table, and its arms may be swung up to receive any sized skein.

2. The main card-cylinder of a flax-carding machine.

3. (*Nautical.*) *a.* A tackle used in tightening standing rigging.

*b.* A rope encircling the ends of the capstan bars to prevent their flying out of their sockets.

**Swift'er.** (*Nautical.*) *a.* A rope used to confine the bars of the capstans in their sockets.

*b.* A rope encircling a boat, parallel to its water line, or on the shear line. It stiffens the boat, and acts as a fender. The girth ropes, spoken of by St. Luke, were passed around the vessel like hoops, to prevent the spreading of the frames. "They used helps, undergirding the ship." — Acts xxvii. 16.

*c.* A shroud from the head of a lower mast to the ship's side, before the other shrouds, and not confined by the cat harpings.

**Swig.** (*Nautical.*) A pulley with ropes which are not parallel.

**Swim'ming-ap'pa-ra'tus.** In the sculptures of Nimroud the soldiers are represented swimming across rivers by the aid of inflated skins.

A float or dress to sustain a person in the water. See LIFE-PRESERVER.

Webb's swim across the Straits of Dover, without artificial floats, and Boynton's trip with a life-preserver dress, are recent feats (1875). The former, which is by far the more remarkable, occupied three tides; his point of landing was 21¼ miles distant, but the length of ground swum over was 39½ miles. Time, 21 hours 22 minutes.

As an aid in teaching swimming, a stout wire resembling a telegraph-wire is now hung just above the water, and drawn tight. On this travels a grooved pulley or "door hanger," and from this hangs down an elastic cord that is fastened to a belt worn by the swimmer. This permits free use of his limbs, gives sufficient support, and allows him to move forward along the length of the wire with ease.

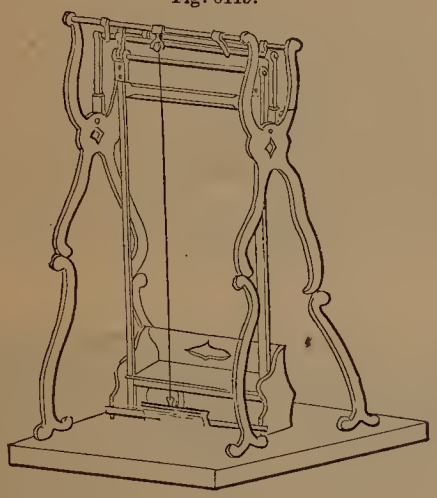
**Swim'ming-tub.** (*Calico-printing.*) A tank of colors, with a floating diaphragm of fabric, on

which a block is laid to color its surface. Also used in making paper-hangings.

**Swing.** 1. A seat suspended in the loop of a rope attached overhead.

In the example, the seat is suspended from rods, and the movable footboard is connected by a rope

Fig. 6119.



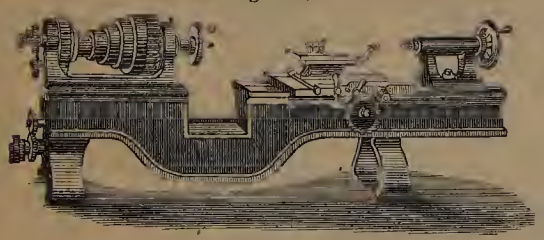
*Swing.*

with a vibrating-frame, and actuates springs which oscillate the swing.

2. (*Vehicle.*) The tip outward from the vehicle of the top of a wheel.

This becomes necessary, owing to the taper of the *spindle* on which the wheel runs. The lower side of the spindle is made horizontal, to obviate any tendency of the wheel to slip in or out, and enable it to

Fig. 6120.



*Gap-Bed Lathe.*

rest squarely in the box of the hub. This gives a tip to the wheel, which is more or less, according as the taper is greater or smaller; no swing being necessary where the spindle is cylindrical. See DISH; GATHER.

The wheel is made *dishing*, so that each spoke, as it arrives at the bottom, may stand perpendicularly beneath the axle.

3. (*Lathe.*) The distance from the *head* center of a lathe to the bed or ways, or to the rest. The *swing* determines the diametric size of the object which is capable of being turned in the lathe; anything larger would interfere with the bed. This limit is called the *swing of the bed*. The *swing of the rest* is the size which will rotate above the rest, which lies upon the bed. In the illustration is shown a *gap*, the bed being cut away to increase the *swing*.

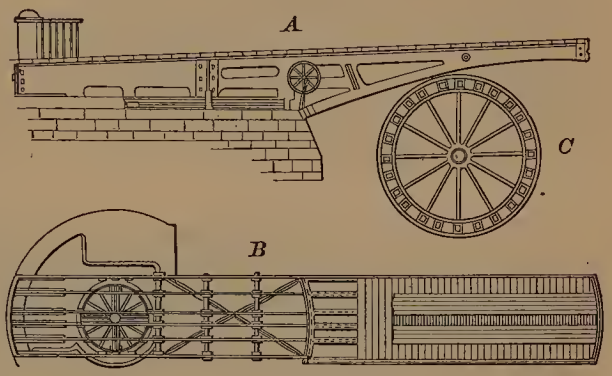
**Swing-beam.** 1. (*Railway Engineering.*) A cross-piece suspended from the truck, and sustaining the car-body, so that it may have independent lateral motion.

2. (*Carpentry.*) A cross-beam supporting an overhead mow in a barn.

**Swing-bridge.** A swivel-bridge, spanning a canal or dock entrance, and opening horizontally to allow a vessel to pass.

It was invented by Nicolas Bourgeois for the ditch

Fig. 6121.




*Swing-Bridge.*

of the Tuileries. His reward was a pension of 1,200 livres per annum.

*Draw* or *swing bridges* are required over dock entrances, canals, or other navigable waters, to allow the passage of vessels with standing masts.

The *swing-bridge* is balanced, and rotates in a horizontal plane. It is usually in two sections, each of which, when opened, is landed on its own side of the dock, the extended ends of the two meeting in the middle when brought into line, and affording a bridge across the water-course.

The tail of the bridge at the St. Katharine's docks, London, works around 240°; the clear opening between the walls is 44 feet 9 inches; the rise in the middle is 3 feet. The turning is effected by a wheel, running horizontally on a number of rollers that run upon a circular cast-iron bed. It is worked by a winch and pinion operating on a segment-rack. The bridge is well balanced, and easily swung upon its central pivot by a single attendant.

*A*, Fig. 6121, is an elevation; *B*, a plan; *C*, an enlarged view of the circular bed.

A swing-bridge on a large scale was constructed on the Great Western Railway of Ireland, to cross the entrance to Lough Atalia. It has two spans of 60 feet each, and is balanced on a central pier of 34 feet diameter.

See Humber, "On Iron Bridges."

Fig. 6122 is the iron swing-bridge over the entrance-lock to the West India Docks, London.

Plate XLI., page 1721, is a view of a swing-bridge on the Amsterdam, Utrecht, and Cologne Railway

Fig. 6122.

*Swing-Bridge, London Dock Entrance.*

where it crosses the Yssel, near Westervoort, Holland.

Fig. 6123 is a view of the swing section of the Mississippi bridge at Keokuk, Iowa.

**Swin'gel.** The swinging piece of a flail. The *swipel.*

**Swing'ing-boom.** (*Nautical.*) The span which distends the foot of a lower studding-sail.

**Swing'ing-saw.** A saw swinging in an arc from an axis overhead.

A weight assists in the effective stroke. (Fig. 6124; see also Fig. 6127.)

**Swing-jack.** A jack for replacing cars on the track; the bottom of the standard is a cylindrical segment, and has a toe working in a slot in the base of the jack.

A pair are used, and the car being lifted while the standards are vertical, the latter are canted to or *swung* over, bringing the wheels of the car in line with the rails. (Fig. 6125.)

**Swing-knife.** A wooden sword 1½ to 2 feet long, and 8 to 10 inches broad, used to scrape the woody portion from flax, a handful of which hangs over a groove in a standing board known as the *swing-stock.*

**Swin'gle.** 1. The effective end-piece of a flail. A *swiple.*

2. An instrument, like a sword, for beating flax; hence the terms, *swingling-knife, swingling-staff, swingling-wand.*

3. The wooden spoke of the wire-drawing barrel, or the roller of a plate-press.

**Swin'gle-tree.** The bar to which the ends of a horse's traces are attached. See SINGLE-TREE.

**Swin'gling-tow.** The coarse part of flax, removed by the *swingle* or *scutcher.* The *shives* are removed from the *hare* in the brake; the *tow* from the finer flax in the *scutcher.*

Fig. 6123.

*Railway-Bridge over the Mississippi, Keokuk, Iowa.*

**Swing Mold-board Plow.** A plow whose mold-board may be shifted to throw the soil to the right or to the left as may be required.

There are several modes of accomplishing this: —

1. By making the plow double, and lowering one or the other to work.

2. By turning the iron portion on an axis, so as to make the sole the landside, and *vice versa*, the mold-board officiating for each in either relation, in one case turning the soil to the right, and in the other to the left.

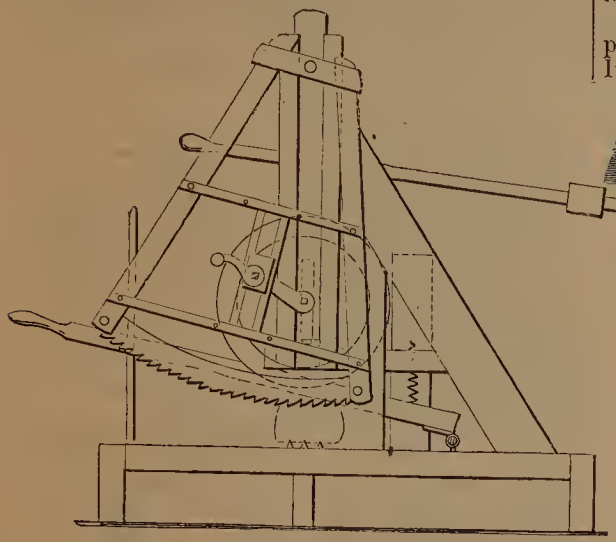
3. Plows having no special mold-board, and in which the colter merely is shifted so as to loosen the furrow slice on that side to induce it to tip over on the other as the share lifts it.

The object is to enable the team to return in and alongside the furrow last made, — an object which is especially desirable in plowing steep hillsides where the furrow can only be thrown *down* hill. See HILLSIDE-PLOW; TURN-WREST PLOW.

**Swing-nose Ba'sin-fau'cet.** A faucet for standing washbowls. The water is turned on or off by rotating the spout on its vertical axis. In the example, the tube answers the fourfold purpose

of handle, plug, cap, and outlet. The hub is screwed

Fig 6124.

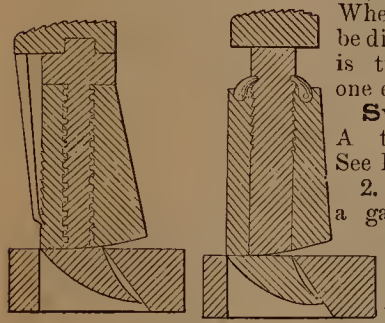


*Swinging-Saw.*

and packed upon the staud-pipe, upon whose top its valve is compressed to close the outlet.

**Swing-pan.** (*Sugar-making.*) (Fr. *Chaudière à bascule.*) A hinged sugar-pan with a spout. When the sirup is to be discharged, the pan is tipped by lifting one edge.

Fig 6125.



*Swing-Jack.*

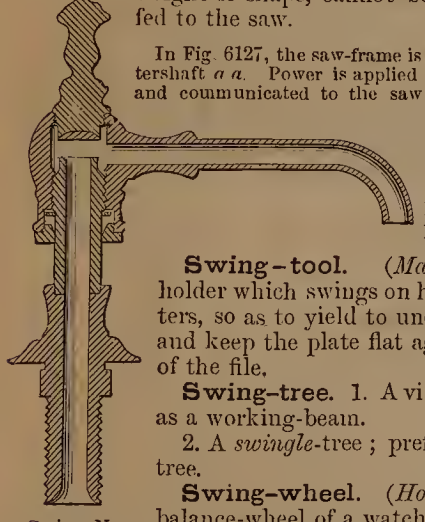
**Swing-plow.** 1. A turn-wrest plow. See HILLSIDE-PLOW.

2. A plow without a gage-wheel. See PLOW.

**Swing-press.** A form of baling-press in which the box is suspended from above by a screw on which it winds as it is rotated. See Fig. 4744, page 2070.

**Swing-saw.** A buzz-saw hung on a pivot, so that it may be swung down to cut on blocks which, by reason of their weight or shape, cannot be conveniently fed to the saw.

Fig. 6126.



*Swing-Nose Basin-Faucet.*

In Fig. 6127, the saw-frame is pivoted by countershaft *a a*. Power is applied at the pulley *b*, and communicated to the saw through a belt from *c* to *d*. The saw is thus free to swing through an arc of about 70°, and is equally operative at all points of the arc.

**Swing-tool.** (*Machinery.*) A holder which swings on horizontal centers, so as to yield to unequal pressure and keep the plate flat against the face of the file.

**Swing-tree.** 1. A vibrating beam, as a working-beam.

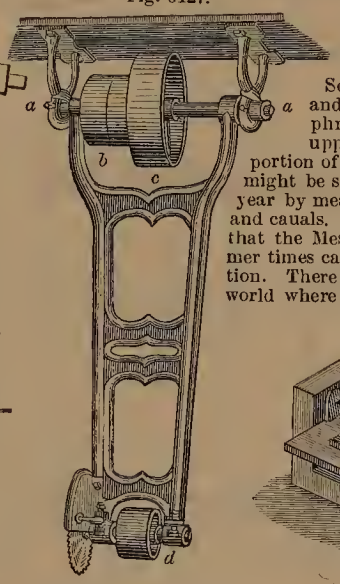
2. A *swingle*-tree; preferably *single*-tree.

**Swing-wheel.** (*Horology.*) The balance-wheel of a watch.

**Swing-wheel File.** (*Watchmaking.*) A file for dressing out the openings in the steel disk from which a balance-wheel is made. A *cross-file.*

**Swipe.** A water-elevator; the well-known well-pole and bucket. Known also as a swipe or SHADÛF. It was common in ancient Egypt, as in the modern; also in the country watered by the Tigris and Euphrates.

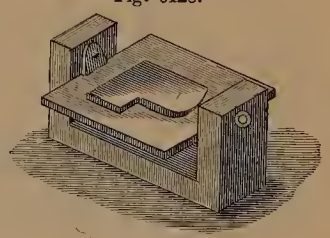
Fig. 6127.




*Swing Cut-Off Saw.*

So abundant is the supply and rapid the fall of the Euphrates and Tigris in their upper course, that the greater portion of the intervening country might be supplied during the whole year by means of dams at intervals, and canals. It was by careful method that the Mesopotamian Valley in former times carried such a large population. There is perhaps no part of the world where remain the evidences of such a large population to the territory. For instance, in the tract of country between the Tigris and the upper Zab, which, says Rawlinson, is the only part of Assyria that has been strictly examined, are distinct remains of an Assyrian canal which has been carried through the more elevated ground by tunneling, and has been led for eight miles in a direction contrary to every other stream in the district. Sluices and dams regulated the supply. The hand-swipe, or *shadûf*, carried the supply to still higher levels. See SWAPE; SHADOOF.

Fig. 6128.



*Swing-Tool.*

Fig. 6129.

*Swipe on the Tigris (Ancient Assyria).*

**Swip'le.** The beating end of a flail.

**Swiss Mus'lin.** (*Fabric.*) A fine, open, transparent cotton goods.

**Switch.** 1. (*Railway.*) The movable rails which connect one line of rails with another.

Switches are known as *stub*-switches and *split*-switches.

In the *stub*-switch the switch-rail has square butted ends, as at *A*, Fig. 6130. The switch-rails require to be moved in direct apposition, or a train running in direction *a b* on rails *a a* would run off the track, were the switch-rails *b b* in connection with the siding, as shown.

In the *split*-switch, *B C*, the switch-rail is pointed, and somewhat automatic. *B* shows it as applied to a main track and siding; *C*, to three tracks, with either of which it may be made to coincide. A train on either of the tracks *c c c* will force over the switch, so as to run on to the main track *d*. A train going in the direction *d c* will run upon such one of the rails *c c c* as may at the time be adjusted in connection by means of the switches.

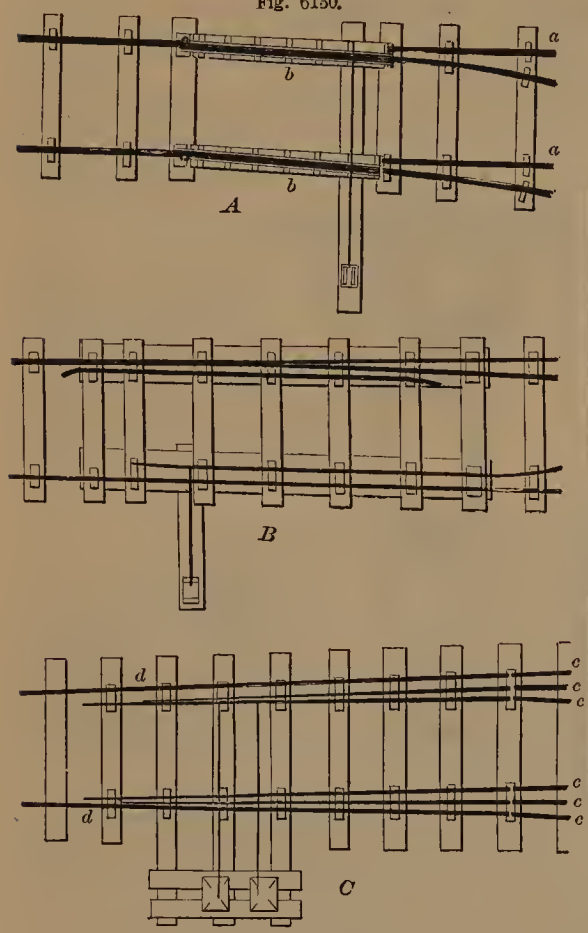
A Y-switch consists of a simple divergent track, which does not again run into the main track.

Switches have been designed to be set in motion by the approaching engine, the object being to restore the main-line connection when a switch has been carelessly left open to a siding. The idea has not been acceptable.

A *portable* switch is one which affords a temporary passage from one track to another, bridging the inside rails.

2. (*Telegraphy.*) A device for connecting one circuit with another, or for dividing a circuit into

Fig. 6130.



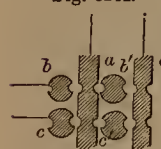

*Railway-Switches.*

two parts, or, in short, for altering any of the connections of a line or circuit. The ordinary *ground* or *lever* switch is a small metallic strip pivoted at one end, the pivot being connected by a wire to one portion of an electrical circuit. The other end of the strap can be turned to rest on an anvil or bed connected with the line desired to be brought into circuit.

The *plug*-switch is one made of pieces of metal connected each to its appropriate wire or part of circuit, but slightly separated from each other, so that the insertion of a plug or pin in the interval between them connects them.

Fig. 6131 illustrates the *peg-switch*. $a\ a'$ are vertical notched bars, the first being connected with the line wire entering a station, and the second with the wire going out. $b\ b'$, $c\ c'$ are metallic buttons to which are connected the instrument wires; all the buttons on the same horizontal line are connected together at the back of the switch. The cut shows the circuit open. To close it, with the office instrument in circuit, metal pegs are inserted in the orifices at $a\ b$ and $a'\ c'$, causing the current to flow through $a\ b$ to the instrument, and thence through $c\ a'$ to the main line. If desired to send through circuit without connecting the instrument, a peg is inserted only at $b'\ a'$ or $c'\ a'$. By a modification of the connections, this form is adapted for a terminal station.

Fig. 6131.



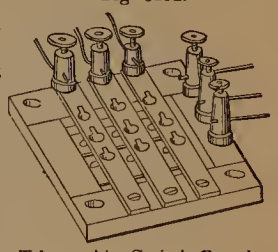

*Peg-Switch.*

By this means also any desired amount of battery power may be applied to one or more circuits by simply inserting metallic pegs in a graduated scale. Every new position in which the peg is placed changes the number of cups brought into connection with that particular line. The same apparatus is also arranged with spring catches, to enable the chief operator to make a connecting loop with any line, or to join two or more lines together by inserting metallic clips connected with the loop lines into the catches. Each line has two catches, and each will hold four clips, so that eight messages may be taken from one line at once. By joining other circuits with these, a still larger number of copies may be made of any one message. This system of switches enables the chief operator to place himself in connection with any wire, and to study the work of the operator without his knowledge. The apparatus is so simple and compact that the wires for several hundred lines may be brought within easy reach of one operator.

3. A key on a gas-burner to regulate the amount of gas passing, and, consequently, the light.

**Switch-board.** An aggregation of switches upon one base, so that any instrument in an office may be connected with any wire or any battery, or cut out altogether.

Fig. 6132.

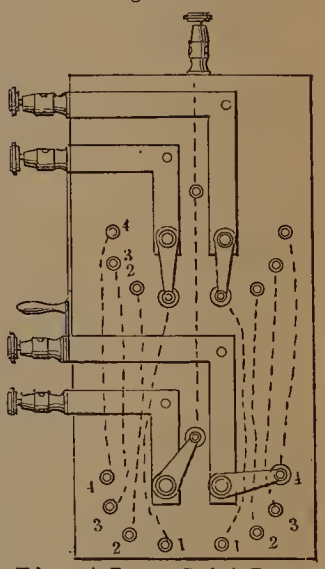


*Telegraphic Switch-Board.*

Fig. 6132 represents a switch-board made of wooden strips (non-conducting) and metallic strips (conducting), so joined in the shape of a frame as to bring the longitudinal metallic strips and the lateral metallic strips across each other for the purpose of making connections between them.

In Fig. 6133, the switch buttons are arranged in pairs corresponding to the number of batteries employed, including the buttons of each pole of a battery in one pair. The battery-pole and its button are connected by a wire.

Fig. 6133.




*Telegraph-Battery Switch-Board.*

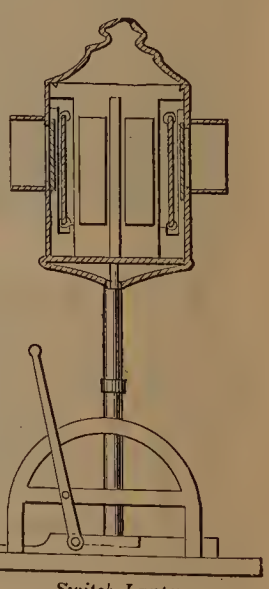
**Switch'ing-en'gine.** A *yard*-engine, or *donkey*-engine, used about a station or depot for making up trains or moving engines which have not steam up.

In Europe, tank-engines are commonly used, rendering unnecessary the tender which carries the water and fuel for the longer journeys of the usual locomotive duty. The European locomotive-engines for switching purposes have box frames made of wrought-iron plates made water-tight, and used to carry the water required by the engine.

See TANK-LOCOMOTIVE.

**Switch-lan'tern.** A lantern on the lever of a railway-switch, to indicate the condition of the switch either by its position or by the display of a colored light.

Fig. 6134.



*Switch-Lantern.*

In the example, the lantern has glasses of different colors set in tubes, so that only the one turned directly in front is visible. The lantern is rotated by the reciprocatory motion of the switch-bar so as to indicate which of several divergent tracks is open.

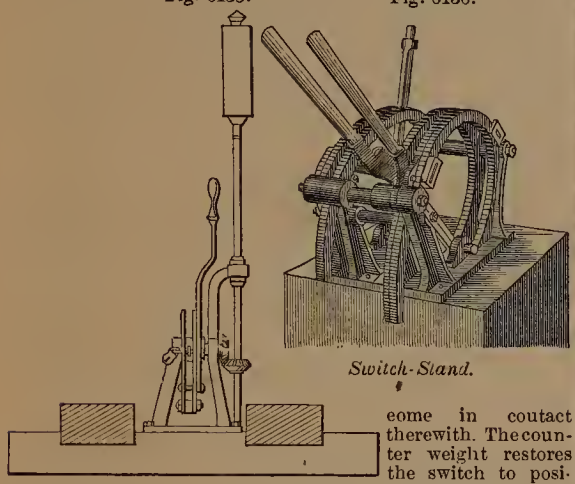
**Switch-lev'er.** The handle and bar by which the switch is moved. See SWITCH-STAND.

**Switch-sig'nal.** (*Railway.*) A lantern, flag, or signboard indicating the position of a switch, whether open to the main or side track or to one of several main tracks. It is frequently constructed so as to be set by the motion of the switch, certain lights or

signals indicating the respective switches. See SWITCH-LANTERN.

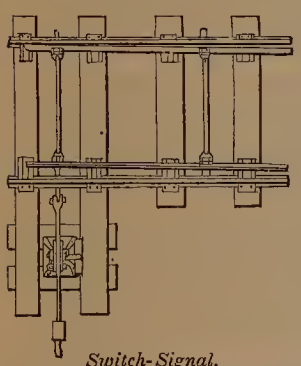
In the example, the ends of the switch-rails lie in the recess beneath the tread, so that the flange of the wheel does not

Fig. 6135. Fig. 6136.



*Switch-Stand.*

come in contact therewith. The counter weight restores the switch to position after movement. The switch-lever shaft is connected by cog gearing with the turning signal-shaft.

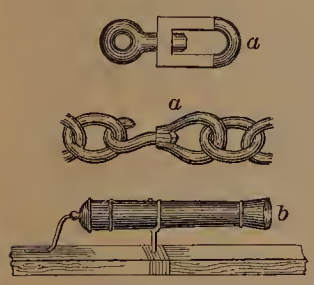


*Switch-Signal.*

**Switch-stand.** (*Railway.*) A fulcrum and locking-device for the levers whereby switch-rails are moved. The levers move in slots in arc-shaped guides, which latter have notches to hold the levers in certain positions which indicate the apposition of the switch-rails with one or another line of rails which come within its range of adaptation.

**Swiv'el.** 1. A twisting link *a* in a chain consisting of a ring or hook ending in a headed pin which turns in a link of the chain. The object is to avoid *kinking*.

Fig. 6137.




*Swivels.*

2. A small cannon *b*, whose trunnions are placed in a carrier, which is pivoted in a socket, so that by the two adjustments the gun may be pointed in any direction. A pivot-gun. See page 1722.

3. (*Nautical.*) A rest, having adjustment in azimuth, for supporting a small piece of ordnance on the gunwale of a boat or vessel.

4. (*Saddlery.*) A loop or runner through which the check-rein passes.

**Swiv'el-bridge.** A bridge which rotates on an axis, moving in a horizontal plane. See SWING-BRIDGE; PIVOT-BRIDGE.

**Swiv'el-gun.** (*Ordnance.*) One mounted on a pivot to traverse horizontally in a circle. See PIVOT-GUN, page 1722.

**Swiv'el-hang'er.** A form of shaft-hanger invented by Edward Bancroft, R. I., in which, to ensure the weight of the shaft being received over the entire length of the box, he hung the box on a universal joint, and made its axis of vibration coincide with the center of the box. This permitted the use of longer boxes than were before practicable, and the pressure per square inch on the surface was lessened.

**Swiv'el-hook.** (*Nautical.*) A turning hook strapped to a tackle-block.

**Swiv'el-hook Block.** A pulley block in which the suspending hook is swiveled to the block, so that the latter may turn to present the sheave in any direction.

**Swiv'el-joint.** A section in a chain or a joint on a rod, which allows the parts to twist without kinking or distortion.

**Swiv'el-loom.** A kind of loom (formerly) used for the weaving of tapes and narrow goods.

**Swiv'el-plow.** A plow having its land-side, sole, and mold-board on an axis, so that the combined portions may be turned over to throw the furrow to the right or to the left. Known in England as a *turn-wrest* plow; in the United States as a SIDE-HILL PLOW (which see). See also TURN-WREST PLOW, the British name for the implement.

**Sword.** 1. A cut and thrust weapon. Its use is of a very remote antiquity, dating as far back as the bronze age. Stone is not adapted for weapons of this kind, and they have not been found among the relics of peoples unacquainted with the use of metals. Artificers in flint could produce nothing better than a short knife. Swords of iron were made by the Chinese, 1879 B. C. This was about the era of Isaac, and three centuries before Cecrops.

Herodotus speaks of an "antique iron sword" as planted on the top of the mound of worship, used by the Scythians. The position was *phallic*, a form of deification familiar to that whole region. The sword found in the great tomb of Kertch was of iron. Their weapons, however, were usually of bronze.

The swords of the bronze age are always more or less leaf-like in shape, double-edged, sharp-pointed, and intended for stabbing and thrusting rather than for cutting. They have no hand-guards. (LUBBOCK.) *a* is an ancient iron sword, introduced to show the difference in shape. *e* to *k* have solid handles. *b c d* have thin handles intended to have *scales* of wood to round out the hand-hold. The handles are short, and are adapted for the use of a smaller-handed people than the present inhabitants of the lands where these specimens were gathered. *a* is an iron sword from a Saxon tomb, England; *b*, bronze sword from Ireland; *c*, from Sweden; *e*, Switzerland; *f*, Neufchatel; *g*, Scandinavia; *g h i j k*, Denmark.

For the sake of comparison are added: —

*l m*, spear-heads from Ireland

*n o*, Irish bronze daggers.

*p q*, bronze knives from Switzerland.

*r*, bronze razor-knife from Denmark.

The Egyptian sword was straight and short, from 2½ to 3 feet in length, having a double edge and a sharp point. It was used, as the monuments show, for cut, thrust, or as a dagger. The handle was hollowed in the center, increasing in thickness toward each end, and the end was surmounted by an emblem, such as a hawk's head or the symbol of Phrah.

Ages ago the superiority of Damascus blades was proverbial. They were very thin, took an exceedingly keen edge, and were so elastic that they could be bent into a circle without retaining a permanent set. Their surface exhibited a series of fine wavy and spiral lines, which were apparently removed by grinding, but restored by the application of acids. From this circumstance it is inferred that they were, like their modern imitations, made by welding together thin laminæ or wires of iron and steel. The art is said to have been lost to Damascus when it was taken by Tamerlane, who carried away the artificers; and though swords are still made there, they do not enjoy the reputation which tradition assigns to those of the ancient manufacture. See DAMASK; STEEL.

When, A. D. 802, Nicephorus, son of Irene of Byzantium, attempted to throw off the yoke of the Saracens, he sent a letter to the Khalif Haroun al Raschid, in which, alluding to the game of chess, he said, "The queen considered you as a rook, and herself as a pawn," and accompanied the letter with a bundle of swords, which his messengers threw down at the foot of the throne. The Khalif smiled, and drawing his scimeter (*samsamah*), cut asunder the Greek swords before him; then dictated this answer: —

"In the name of the most merciful God! Haroun al Rasehid, Commander of the Faithful, to Nicephorus, the Roman dog. I have read thy letter, O thou son of an unbelieving mother. Thou shalt not hear, thou shalt behold my reply."

He ravaged Asia Minor at the head of 300,000 soldiers, and

Fig. 6138.

*Ancient Swords, etc.*

dictated a humiliating peace. About this time Charlemagne was subduing the Slavi of the Elbe and the Avars of Hungary. The king of the Franks at Aix-la-Chapelle received from the great Haroun of Bagdad presents, consisting of the keys of the holy sepulcher, a consecrated standard of Jerusalem, a wheel-clock that struck the hours, an organ, an ape, and an elephant.

Scott, in the "Tales of the Crusaders," describes a meeting between Richard Cœur de Lion and Saladin. Saladin asks Richard to show him the strength for which he is famous, and the Norman monarch responds by severing a bar of iron which lies on the floor of his tent. Saladin says, "I cannot do that," but he takes a down pillow from the sofa, and, drawing his keen blade across it, it falls in two pieces. Richard says: "This is the black art; it is magic; it is the Devil; you cannot cut that which has no resistance." And Saladin, to show him that such is not the case, takes from his shoulders a scarf which is so light that it almost floats in the air, and, tossing it up, severs it before it can descend. George Thompson states that he saw a man in Calcutta throw a handful of floss silk into the air, and a Hindoo sever it into pieces with his saber.

Europe woudered much at the gorgeous profusion of the Orient, and even the "brand *Excalibur*" must have been of Eastern make, —

"My brand Excalibur
Which was my pride."

"For all the haft twinkled with diamond sparks,
Myriads of topaz-light, and jacinth-work
Of subtlest jewelry."

No wonder Sir Bedivere coveted the sword of this old British chief and hid it "in the many-knotted water-flags," as related in the chronicle of the old harper who is always a little below concert pitch.

The famous sword of Orlando was said to have been the work of the fairies, and its name *Durandal* (*dur en diable*, "as hard as the devil") is indicative of its origin, and accounts for the fact (?) that he was able to cleave the Pyrenees with it. It was also called *Durandarte*, *Durindana*, *Durlindana*.

*Curtana* was another famous sword of Orlando. Its name was given to the "first royal sword" of England from a very early period; in the wardrobe accounts for 1483 it is so designated.

*Morglay* (*glaive de la mort*) was the sword of Sir Bevis of Southamptou.

*Tizona* was the famous sword of the Cid.

*Andrea Ferrara*, so long believed to be the name of a celebrated Italian sword-maker, must be given up. *Andrea* is only an occasional prefix, and *Ferrara* is most probably a corruption of *ferrarium*, a weapon-smith, or cutler.

The Lord Mayor of London used to bear three swords, — a *common*, a *Sunday*, and a *pearl* sword. These were *not* famous in chivalric records.

Japanese officials of a certain grade wear two swords, the hilts projecting out a foot in front of the person of the wearer. One of them is a heavy, two-handed weapon, pointed, and sharp as a razor; the other short, like a Roman sword, and kept in the same serviceable state.

Swords and sabers have a *blade*, either straight or curved, with a *tang*, which is inserted into a spindle-shaped piece of wood, covered with leather, and wrapped around with brass wire; these form the *gripe*, which, with the brass knob at the end called the *pommel*, constitutes the *hilt*. The hand is protected by the *guard*, which is a curved piece of metal, consisting of from one to three branches, and usually provided with a broad plate of metal, the guard-plate, at the point where it is attached to the blade.

The scabbard is the case, usually of leather or steel, into which the blade is inserted.

The blade of a sword consists of: The *tang*, which enters the hilt; the *shoulder*, which abuts against the end of the hilt; the *forte*, the half of the blade nearest the hilt; the *foible*, or *foible*, the half part nearest the point; the *point;* the *back;* the *flat;* the *edge*.

The hilt consists of (the parts varying in different kinds of swords): The *pommel*, or back piece; the *gripe;* the *bars* of the basket, in sabers; the *stool*, or *guard*-plate; the *bow*, in sergeants' swords and horse-artillery sabers; the *cross*, as in the old Highland claymore; the *linguets*, in foils and rapiers.

The successive operations in sword-making are forging, hammering, swaging, hardening, tempering, setting, grinding, glazing, hilting, and proving.

In the process of making swords, as practiced at the factories, pieces of Sheffield steel called *double molds*, each of the length of two blades, the ends for the tangs being of iron, are employed. These are cut or broken in the middle, the tangs are forged first, and afterward the blade, the furrow or furrows being formed at the same time. Twenty-five reheatings are required for this purpose. The blade is then heated and plunged into cold water, rendering the metal extremely brittle; again heated, and the distortions caused by the hardening corrected by rehammering, when it is again heated till its surface assumes the proper color, of which the workman is the judge, to insure its having the due hardness and flexibility when tempered, which is done by plunging it at this stage into cold water.

It is next ground. The stones employed for finishing the furrows have raised flutings suited to the furrows of the particular kind of blade to be operated on.

The polishing is performed upon wheels of various sizes, with lard-oil and flour of emery, the blade being frequently dipped into lime-dust during the operation. A brush-wheel, sprinkled with fine crocus-powder, imparts the final polish. The scabbards, if of metal, the hilts, and other metallic parts are treated in like manner.

In making the metallic scabbard, a piece of sheet-steel is laid over the top of an open vise, and beaten with a wedge-shaped wooden mallet, causing the edges to approach each other. The sides are then beaten on each side until the edges nearly unite, and the scabbard is slipped upon a mandrel and hammered until the joint is closed; it is then soldered, and the tip, or *drag*, and the bands are put on.

The *gripe*, or handle, is made of walnut, with a metallic strip at the back; it is shaped by files, a tenon for the ferrule made at the end, and *balled*, that is, surrounded with grooves, by means of a triangular file: the edges of these grooves being afterward rounded, or "balled," with another file. It is then drilled in a lathe, with a longitudinal hole for the tang, after which it is covered with dogfish-skin, secured by winding cord or wire around the gripe in the grooves between the balls.

The hilt, or guard, is cut from sheet-metal, and hammered into shape, then polished, and finally fixed to the sword. This operation is called mounting.

Sword-blades, resembling those of Damascus, are made at Solingen, in Germany. A fagot is first formed of alternate fine bars of iron and steel. It is drawn out, doubled, and twisted several times, and then formed into a ribbon. Two such rib-

bons are welded together, inclosing between them a thin blade of the best-cutting English steel. After polishing it, it is dipped in diluted sulphuric acid, to give it a pattern.

Sword-blades, resembling in appearance the Oriental blades, and equal to them in quality, have been made in Germany, by the process of Prof. Crevilli, of Milan.

"A long, flat piece of malleable steel, 1½ inches in breadth and ⅛ inch in thickness, is first bound with iron wire, at intervals of ¼ inch. The iron and steel are then incorporated by welding, and repeated additions (10 to 20) of iron wire made to the forging, in the same manner as the first. The forging is then stretched, doubled, and welded; and the process is repeated as often as may be desired, when the material is brought to the shape required by the hammer on the anvil.

"By filing semicircular grooves on both sides of the blade, and again subjecting it to the hammer, a beautiful rosette-shaped damask is obtained. By special manipulation the pattern may be made to assume other forms. The pattern is brought out by the application of aqua fortis and vinegar. An idea of the extraordinary tenacity of these blades may be formed from the fact, that out of 210 blades examined by a military commission, and each of which was required to bear three cuts against iron and two against a flat wooden table, not a single one snapped or had its edge indented." (See WOOTZ; DAMASKEENING.)

2. (*Weaving.*) One of the bars dependent from the *rocking-tree* and supporting the *lay*.

3. The scutching-blade of the flax-dresser. See SCUTCHER.

**Sword-bay'o-net.** A bayonet with a blade like a sword, and capable of being detached from the barrel and used like a sword.

**Sword-belt.** The waist-belt from which a sword is slung.

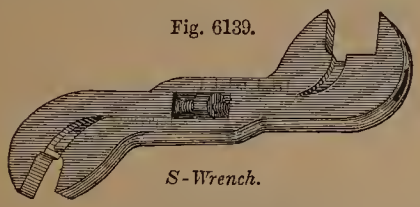
**Sword-cane.** A cane with a concealed sword.

**Sword-knot.** A knotted ribbon on a sword-hilt.

**S-wrench.** A spanner or wrench of an S-shape, to enable it to reach parts not so readily approached by the ordinary monkey-wrench. It has two jaws of different angles, and an adjusting screw in the stock.

In Fig. 6139, the respective pairs of jaws are operated by a right and left screw and thumb-piece. Scales are placed on the

Fig. 6139.



*S-Wrench.*

respective halves, which have a motion on each other, each piece having an inner and outer jaw of the respective pairs.

**Sym'bol-print'ing.** (*Telegraphy.*) A system of printing in dots and marks (see MORSE ALPHABET) or other cipher, as distinct from printing in the usual Roman letter. (See PRINTING-TELEGRAPH.) The *dots* and *dashes* of the Morse, or similar system, may be produced by pressure on, or penetration of the paper (Morse), or by a chemical action at the point of contact of the styles (Bain), or the passage of the electric current.

**Sym'pa-thet'ic Ink.** A colorless ink, the writing made with which is made visible by a subsequent operation, — warmth, or other reacting stimulant. See INK, page 1187.

**Sym-phys'e-o-tome.** (*Surgical.*) Fr. *Couteau symphysien.* A knife used in operation of the division of the *symphysis pubis* to enable the pelvis to open and permit delivery; the *Sigaultian section.*

**Sym'pi-e-som'e-ter.** Invented by Mr. Adie of Edinburgh. It consists of a column of oil supported by atmospheric pressure, and rising, not like the mercury of the barometer into a vacuum, but against a body of hydrogen gas, which acts like a spring against the column of oil; and as the elasticity of the hydrogen varies with every change of temperature, a movable thermometer-scale is attached for making the necessary corrections.

The glass tube *b* is about 18 inches in length and $^{7}_{100}$ of an inch in internal diameter. At the upper extremity is a cylindrical vessel *a*, 2 or 3 inches long and half an inch in internal diameter. The lower extremity is turned upward, and terminates in a vessel *c*. The hydrogen is contained in the space *b a*, and the oil, colored red with alkanet, occupies the space between *b c*.

Fig. 6140.

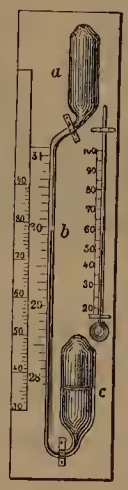



Fig. 6141.

*Sympiesometers.*

The sympiesometer is graduated by placing it together with a standard barometer and thermometer in a glass vessel, in which the pressure of the air can be varied at pleasure. The top of the column is marked at the points where the barometer shows 27, 28, 29, 30, 31 inches respectively. The spaces between the marks, coinciding with the inches of mercury, are then subdivided into 100 equal parts each, and the great range makes the instrument valuable for recording minute variations, subject to correction, depending on the variation in the volume of the hydrogen due to changes of the temperature. A graduated sliding scale assists in reaching the corrected result.

Fig. 6141 is another form of the instrument.

**Syn-cli'nal Line.** (*Mining Engineering.*) The axis of valley curvature of strata, at which the beds which are tilted in opposite directions are supposed to meet. Opposed to *anti-clinal.*

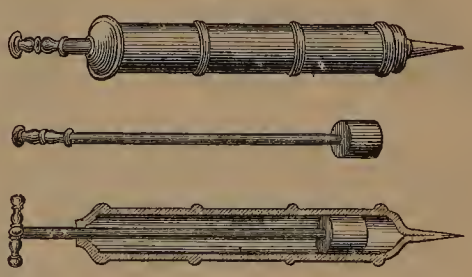
**Syn-os'te-o-tome.** (*Surgical.*) A dismembering-knife.

**Sy'pher-ing.** (*Shipwrighting.*) Lapping the chamfered edge of one plank over the similarly chamfered edge of another, so as to form a joint with a plane surface.

**Sy'pher-joint.** (*Carpentry.*) A lap joint for the edges of boards, leaving a flat or flush surface.

**Sy'ren.** See SIREN. See also "Tyndall on Sound," London, 1875, pages 61, 82; and frontispiece; also "London Engineer," January 21, 1876.

Fig. 6142.



*Syringe, by Hero.*

**Syr'inge.** 1. A small hand-pump for ejecting water. Well described by Hero in his "Spiritalia." He describes it for injecting a liquid, or, by an inverse operation, withdrawing pus from a wound. Fig. 6143 shows the squirts which formed a part of the horse-play of the carnivals and sports of the Middle Ages.

See under the following heads: —

Catarrhal syringe.
Catheter-syringe.
Condensing-syringe.
Ear-syringe.
Elastic-bulb syringe.
Enema-syringe.
Exhausting-syringe.
Eye-syringe.
Garden-syringe.
Hemorrhoidal syringe.
Hypodermic syringe
Injection-syringe.
Ointment-syringe.
Penis-syringe.
Probe-syringe.
Squirt.
Transfusion-syringe.
Universal syringe.
Vaginal syringe.

2. (*Surgical.*)

Fig. 6143.

*Squirts.*

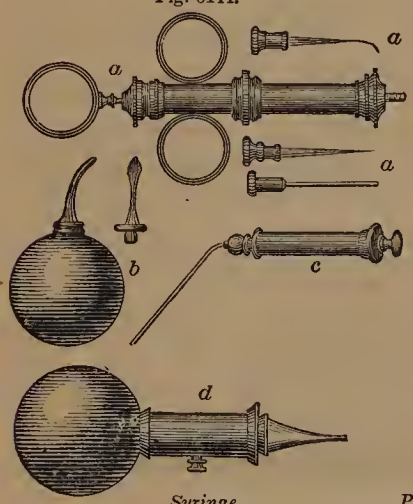
*a*. Anel's silver eye-syringe with silver and gold points.
*b*. Liebold's subpalpebral syringe.
*c*. McFarlan's lachrymal syringe.
*d*. Rubber-bag ear-syringe.

Clotworthy's syringe, August 24, 1875, has a removable nozzle over the rounded end of a vaginal syringe. It may be used for either sex.

Wheelock's, April 11, 1865, has orifices to discharge the liquid backwardly.

The pneumatic syringe is an instrument for illustrating the compressibility of gases. It consists of a strong glass tube having a tightly fitting piston, which, on being forced down, compresses the gas into a bulb proportional to the amount of pressure applied.

Fig. 6144.




*Syringe.*

Fig. 6145.

*Pneumatic Syringe.*

Reed's syringe for cattle is used for injecting medicine, or as a stomach pump. It does not differ materially except in size from the ordinary surgical apparatus for an analogous purpose. When used as an injector, the induction end of the syringe is plunged in a bucket containing the medicament, and the injection-tube is introduced through the esophagus into the paunch, to which the medicine is directed. When used to relieve a distended paunch, the long tube is secured to the induction end of the syringe, and the fermenting pultaceous mixture and gas are ejected at the side of the cylinder.

**Syr'inge-case.** A box for the compact stowage of the surgical syringe. The injecting-tubes rest in the notches of a tray, which has an aperture to allow the projection of the upper part of the bulb.

**Syr'inge-en'gine.** One used as a fire-engine some centuries since.

**Syr'inge-valve.** A peculiarly constructed valve used in syringes. The valve-guide stem has an end knob, by which its falling out is prevented.

**Syr-ing'o-tome.** (*Surgical.*) A bistoury, concave on its edge, and terminated by a long, flexible, probe-pointed stylet. Formerly used for *fistula in ano*, by incision.

**Syr'inx.** (*Music.*) A wind-instrument, consisting of a row of parallel reeds of varying lengths, and played by blowing into their open, upper ends. Their varying lengths determine their pitch. The usual number was seven, but some are found having from three to nine.

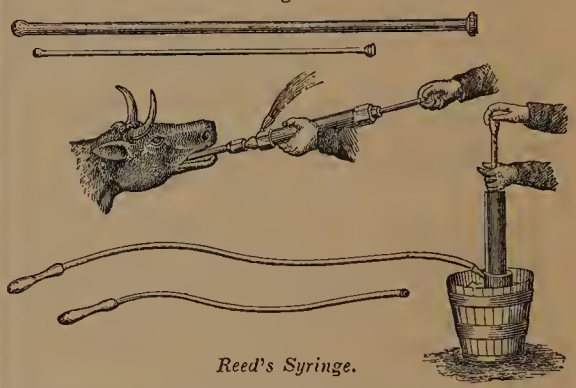
Probably the *ugab* of the Hebrew Bible, which in our version is rendered *organ*. The *sumphonia* of the Hebrew (*zampogna* is the Italian bagpipe) was probably a syrinx with bellows,—the rudimentary organ.

The pandean pipes, eight in a row, and of graduated lengths, are shown on old monuments and gems.

A syrinx with bellows is shown on one of the ancient terra-cotta exhumed at Tarsus, Asia Minor. It is supposed to be 2,000 years old, as coins of the second century B. C. were imbedded in the earth in its vicinity.

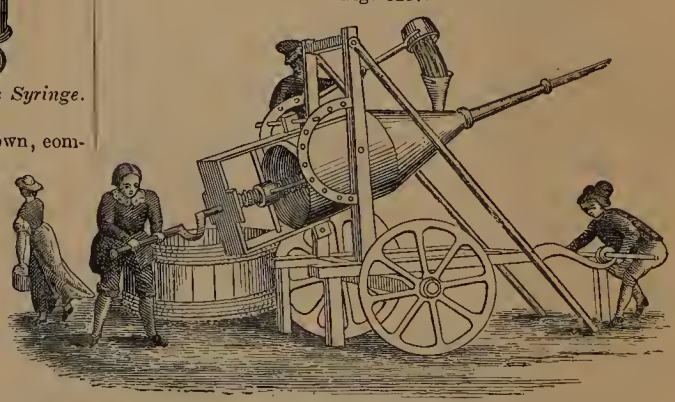
The Peruvians had a syrinx with eight pipes. One specimen of the instrument was about four inches wide, the longest pipe having also about that length. They were made of cane or stone. The one above referred to was made of a talcose stone, and was peculiarly ornamented. It was found on the breast of a skeleton in one of the *huacas*, or Peruvian tombs. Four of the tubes had lateral finger-holes, by stopping which the tones were lowered a semitone. It appears to have been called the *huayra-puhura*, whatever that may mean. It had one more pipe than the classical or the modern instrument.

Fig. 6146.



*Reed's Syringe.*

Fig. 6147.



*Syringe-Engine.*

The *syrinx* is shown in English MS. of the ninth and tenth centuries. In one of the eleventh century, the tubes are inserted in a boat-shaped box.

The syrinx was used by the Romans as a noisy improvement on hissing, in condemning bad actors; the English *cat-call* and the American *whistle* are its legitimate successors. The occupants of our peanut galleries, however, use it indiscriminately for praise or blame.

It may be said of them, as Quince the carpenter says of Pyramus,—

"He goes but to see a noise."

**Syr'up-stand.** See SIRUP-STAND.

# T.

**Tab.** 1. (*Fulling.*) One of the revolving arms which lift the beaters of a fulling-mill.

2. (*Shoe.*) A latchet or flap of a shoe or half-boot, formerly fastened with a buckle, of late by a string.

3. The metallic binding on the end of a shoe or corset lace. A *tag.*

**Tab-a-ret'.** (*Fabric.*) A stout, satin-striped silk goods.

**Tab'by.** (*Fabric.*) Silk or other stuff having an irregularly waved or watered surface produced by pressure, usually between engraved rollers in the mode of calendering, known as *tabbying.* There is but little difference between *tabbying*, *watering*, and *moiré*, the effect in each case being produced by the flattening of some of the fibers while the others remain undisturbed, causing the different parts to reflect the light unequally.

"My false taby wastecote with gold lace." — PEPYS, 1661.

**Tab'by-ing.** Passing fabrics between engraved rollers to confer a wavy or watered appearance. Analogous to *watering*, or *moiré.* See TABBY.

**Tab'er-na-cle.** (*Nautical.*) An elevated socket for a boat's mast; or a projecting post to which a mast may be hinged when it is fitted for lowering to pass beneath bridges.

**Tab-i-net'.** (*Fabric.*) A goods of silk and wool, adapted for window-curtains.

**Ta'ble.** 1. (*Furniture.*) A piece of furniture on which viands or work is placed, so as to be readily reached by persons sitting adjacent thereto.

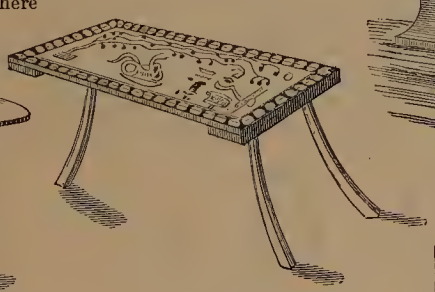
Tables are known by size, shape, construction, material, purpose, etc., as,

| | | |
|---|---|---|
| Card, | Dining-room, | Self-waiting, |
| Carving, | Extension, | Steam-heated, |
| Center, | Folding, | Toilet, |
| Chess, | Ironing, | Work, etc. |

The Egyptians used chairs and tables in what we consider the regular civilized way; neither reclining on couches, as in the lazy way of the later Romans, nor squatting on a rug, as the modern Oriental. Their tables were supported by central stems or by legs, the latter terminating in carved feet like those of lions or dogs. They were of metal, stone, wood, or ivory; were carved, painted, and gilded; square, round, or oblong.

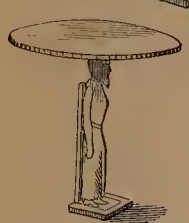
The annexed cut shows one with a central post, where the figure of a captive forms the shaft, and a flat base the foot.

Fig. 6149.



*Egyptian Table (from Salt's Collection).*

Fig. 6148.



*Egyptian Table (from Wilkinson).*

Fig. 6149 is a table in the collection of Mr. Salt, and is inlaid with ornaments of vines and the peculiar serpent figure that is represented in connection with wine. Possibly to suggest that it "stingeth like an adder," as they were fond of moralizing at their feasts.

The Romans used three-legged, four-legged, and central-stem tables (*monopodium*): also semicircular, lunette, and S-shaped tables (*sigmata*). Tablecloths do not appear to have been used by the Greeks or Romans.

A revolving table, to present the viands to the guests in rotation, was used in Varro's villa at Casinum.

For ancient tables, see Fosbroke's "Ency. Antiq.," I. 380 *et seq.*

2. (*Glass-making.*) *a.* The flat disk of crown glass which is made from a bulb on the end of a *blowing-tube*, transferred to a *ponty*, gradually and finally *flashed* into a disk by rotating in front of a FLASHING-FURNACE (which see).

*b.* The flat plate with a raised rim, on which plate glass is formed. See Fig. 1181.

3. A chess or backgammon board.

4. (*Diamond-cutting.*) *a.* A form of diamond-cutting. The top of the stone is ground flat with a corresponding flat bottom of less area, with its four upper and lower facets cut parallel to each other. See DIAMOND-CUTTING.

*b.* The upper flat surface of a brilliant cut diamond; the zone facets around it are known as the *bizet.* The lower flat face, the *collet*, which converts the *culasse* into a truncated pyramid, is $\frac{1}{5}$ of the size of the table, and parallel therewith. See BRILLIANT.

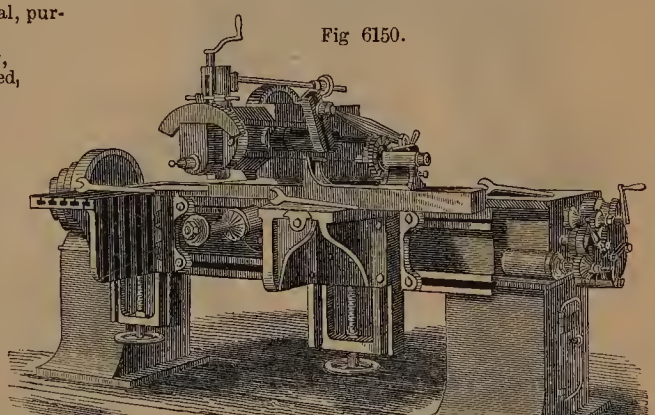
5. (*Architecture.*) *a.* A smooth, simple member or ornament of various forms, but most usually in that of a long square.

*b. Table* or *tablet moldings*, horizontal bands or moldings, such as base-moldings, strings, cornices, etc.

6. A tablet. Formerly a board, slab, or leaf to contain writing. The term is nearly obsolete as a writing surface, but is still useful as indicating lists and calculations, generally in lines and columns.

7. (*Weaving.*) The board or bar in a draw-loom to which the tails of the harness are attached.

Fig 6150.

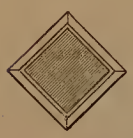


*Shaping-Machine (N. Y. Steam-Engine Co.), with Two Tables.*

8. (*Machinery.*) The part on which work is placed to be operated upon; the term *bed* is also used to designate the large flat table of a planing-machine. Shaping-machines have single or double beds, the latter being lighter than one continuous one of equal reach, besides having an additional adjustability, as shown in the figure, where an object of irregular shape may be supported to present an accurately horizontal surface while it rests upon two tables of varying hights.

The shaping-machine shown in Fig. 6150 has a cutting-bar with 16 inches stroke, and the head has a traverse of 6 feet, with quick return-motion. The stroke is adjustable to anything less than 16 inches. It has two tables for holding work, both of which are movable up and down by screw and hand-wheel, and longitudinally by means of rack and pinion, with ratchet-lever.

Fig. 6151.



**Ta'ble-an'vil.** A small anvil adapted to be screwed to a table for bending plates of metal or wires, making small repairs, etc. See STAKE.

**Ta'ble-di'a-mond.** (*Diamond-cutting.*) *Table-cutting* is adopted with flat, thin gems, which have not sufficient protuberance to be cut as *rose diamonds* or brilliants.

*Table-Diamond.*

**Ta'ble-fork.**

The table-fork is a modern invention. Many centuries before its common use the article was known. It appears to have been a matter of taste and cleanliness with some persons in Constantinople as early as the eleventh century. One of silver, from a ruin on the Via Appia, is engraved by Caylus, as a classical antique. They are stated to have been brought from China to Italy, where, in Coryatt's time, they were of silver, iron, and steel, and used by gentlemen They are mentioned in a charter of Ferdinand I., king of Spain, A. D. 1101, and in the wardrobe accounts of Edward I. of England. See also FORK.

Forks are made from rods of steel, about ⅜ inch square. The tang and shank are first roughly formed, and cut off with about an inch of the square rod, which is drawn out flat to the length of the prongs. The shank and tang are then heated and shaped by means of a die and swage. The flat part is then brought to a white heat and swaged between two corresponding dies, one on an anvil and the other upon the face of a drop-hammer, like that of a pile-driver, which is let fall from a hight of 7 or 8 feet; the thin film left between the prongs is afterward cut out with a fly-press. The forks are then annealed, their prongs filed, bent to the proper curve, reheated, hardened by plunging in cold water, and afterward tempered at the heat at which grease inflames.

Fig. 6152.

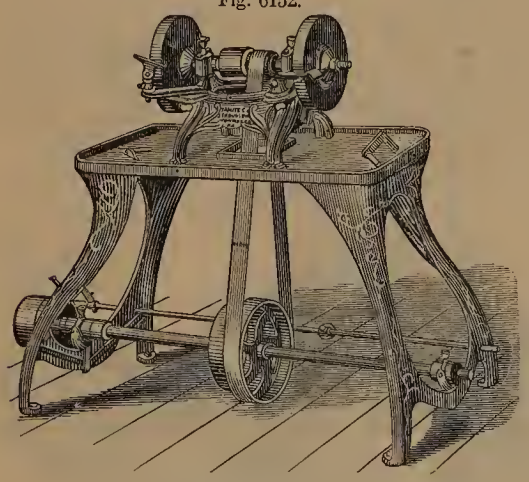


*Table-Grinder.*

**Ta'ble-grind'er.** A form of grinding-bench.

**Ta'ble-knife.**

Sharon Turner ("History of the Anglo-Saxons") observes, that "in all ancient pictures of eating, etc., knives are seen in the hands of the guests, but *no forks*." Their use at table was, no doubt, coeval with that of the table itself. Forks are of very modern introduction. Coryatt, in his "Crudities," published 1611, says: "I obserued a custome in all those Italian cities and townes through which I passed that is not vsed in any other country that I saw in my traules, neither doe I thiuk that any other uation of Christendome doth vse it, but only Italy. The Italians and also most strangers that are commorant in Italy, doe alwaies at their meals vse a little forke when they cut their meate. For while with their knife, which they hold in one hand, they cut their meate out of the dish, they fasten their forke, which they hold in their other hand upon the same dish so that whosoever he be that sitting in the company of others at meate, shoul vnaduisedly touch the dish of meate with his fingers from which all others at the table doe cut, he will give occasion of offence unto the company as hauing transgressed the laws of good manners, in so much that for his error he shall be at least broue-beaten, if not reprehended in words."

Even when Heylin published his "Cosmography," 1652, they appear to have been a novelty in England, as, after speaking of the chopsticks used by the Chinese, he adds, "The use of silver forks, which is by some of our spruce gallants taken up of late, came from thence into Italy, and from thence into England."

In a curious class of knives of the sixteenth century, the blades have on one side the musical notes to the benediction of the table, or grace before meat, and on the other, the grace after meat. (See CARVING-KNIFE, page 492.)

The set of these knives usually consisted of four. They were kept in an upright case of stamped leather, and were placed before the singer, accordiug to the adaptation of each part to the voice, indicated upon them.

In forming a table-knife, the blade is forged at the end of a bar of shear-steel, and then cut off. To it is then welded a piece of iron, which is shaped to form the bolster, shoulder, and tang. The bolster is formed between swages. The blade is then reheated and finished on the anvil, or smithed, as it is termed, stamped, tempered, and ground. The handle is then attached.

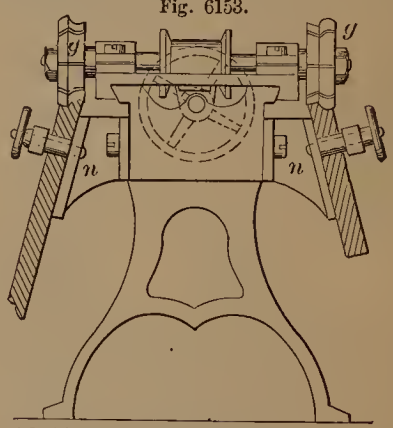
The manufacture of table-cutlery has of late years been introduced into this country, where a machine has been invented for forming knife-blades. This machine has been adopted in Europe.

**Ta'ble-lathe.** A small lathe attached by a clamp to a table and run by hand, or by a driving-wheel in a movable frame. See HAND-LATHE.

**Ta'ble-leaf Joint.** A peculiar form of furniture joint used in desk and table leaves, rules, and in some kinds of shutters. It has a molded edge, forming a *quarter-round*, the respective portions being *hollow* and *swelling*, so as to move on each other in manner of a knuckle-joint. The pintle occupies the position of the axis of the curved surfaces. Also known as a *rule*-joint.

Fig. 6153 shows a machine for planing the molding edges; the cutter-heads *g g* have the shape the converse of the one required on the material. The cutter-heads and mandrel are upon

Fig. 6153.



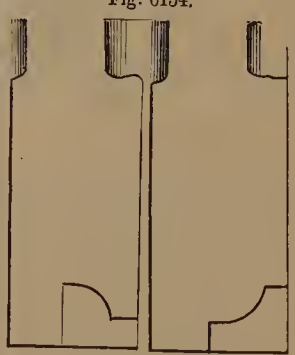

*Machine for making Table-Leaf Joints.*

a sliding carriage, the work being dogged to the rests *n n*, whose inclination secures the proper presentation of the staff to the cutters.

**Ta'ble-plane.** (*Joinery.*) A furniture-maker's plane for making those joints on the flaps of table and side-boards called *rule-joints*.

The respective parts have *rounds* and *hollows*, and the planes are made in pairs, counterparts of each other.

Fig. 6154.



*Pair of Table-Planes with Fence.*

Fig. 6155.

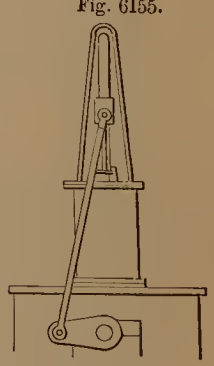


*Table-Engine.*

**Ta'ble Steam-en'gine.** A form of engine in which the cylinder is fixed upon a *table-like* base.

The piston-rod has a cross-head working in straight, slotted guides on the top of the cylinder, and is connected, by rods at each side, with two parallel cranks on the shaft under the *table*.

**Tab'let.** 1. (*Architecture.*) A coping on a wall or scarp.

2. A plate or slab for writing upon.

The *pugillares* of the ancients were made in the form of books, the leaves of skin, ivory, parchment, wood, fixed within covers and held by a wire or ribbon which passed through holes in all of them, so that they opened like a fan. The terms *duplices*, *triplices*, *quin-*

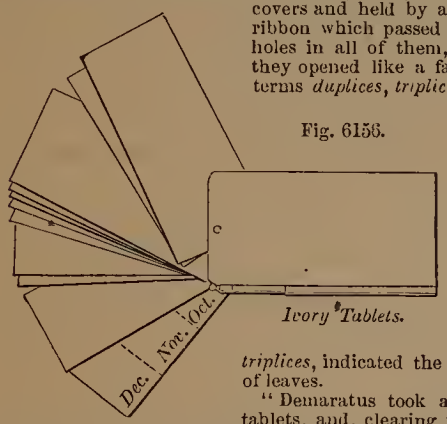



Fig. 6156.

*Ivory Tablets.*

*triplices*, indicated the number of leaves.

"Demaratus took a pair of tablets, and, clearing the wax away from them, wrote what the king [Xerxes] was purposing to do, upon the wood whereof the tablets were made; having done this, he spread once more the wax over the writing, and so sent it." — HERODOTUS, VII 239.

Ivory is now commonly used.

**Ta'bling.** 1. (*Nautical.*) An additional thickness of canvas on portions of a sail exposed to chafing, or to strengthen the sail at certain points, as the edges.

2. (*Carpentry.*) A *coak* or tenon on the scarfed face of a timber, designed to occupy a counterpart recess or mortise in the chamfered face of a timber to which it is attached. See SCARF.

**Ta'bor.** (*Music.*) A small shallow drum used to accompany the pipe, and beaten by the fingers.

**Tab'ou-ret.** 1. An armless seat.

2. An embroidery frame.

**Tab'ret.** (*Music.*) A musical instrument of the small drum or tambourine class.

The word rendered *tabret* or *timbrel* in the King James version of the Bible is the *toph* of the Hebrew Scriptures; a word which is probably allied to *doff*, *diff*, or *adufe*, a small hand-drum of the East. The *toph* was evidently a tambourine or hand-drum, like the Egyptian *darabooka*, and is interesting in connection with the rejoicing of Miriam and the sad episode of the daughter of Jephthah.

**Tache.** A pan in a *battery* of sugar-pans.

All the pans in a battery are termed *taches*. The term is, however, often especially applied to the *smallest* of the five; that immediately over the fire from which the concentrated juice is transferred to the cooler, also called the *striking-tache*.

**Ta-chom'e-ter.** An instrument for measuring the velocity of moving bodies. Woltmann's, for measuring the speed of flowing liquids, has several spiral vanes on a shaft carrying an endless screw, which turns a series of geared wheels. On being placed in a current, the vanes assume a position perpendicular thereto, and their rotation actuates the clock-work mechanism which is graduated to indicate the velocity in miles per hour, or other units of measurement.

See SPEED-GAGE; SPEED-RECORDER; VELOCIMETER, etc.

**Tack.** 1. (*Nautical.*) *a.* The lower forward corner of a fore-and-aft sail.

*b.* The lower, weather corner of a *course*, or lower square-sail.

*c.* The rope by which the forward lower corner of a course or stay-sail is drawn forward and confined.

*d.* A rope by which the lower corner of a studding-sail is drawn outward and held to the boom.

2. *a.* A small, flat-headed, sharp-pointed nail. At the principal seat of the tack manufacture in England, it is not an uncommon feat for the workmen to forge 1,200 tacks so small as to be contained in the barrel of an ordinary goose-quill; their weight being about 24 grains. Tacks are known as *carpet*, *leathered*, *gimp*, *brush*, *broom*, *felting*. Their size is designated by the weight of 1,000, as 3 ounce, 6 ounce, 8 ounce, etc.

*b.* A short pin with a large flat head, used by draftsmen to hold a sheet of paper on the drawing-board; a *thumb-tack*; called also *drawing-pin*.

**Tack-block.** (*Nautical.*) A block for the tack of a sail. The studding-sail tack-blocks are at the ends of the booms.

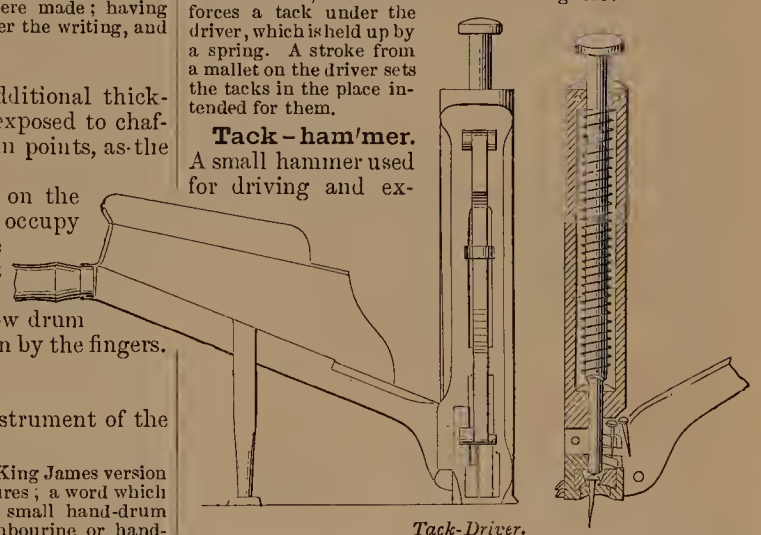
**Tack-claw.** (*Saddlery.*) A bifurcated tool for drawing tacks. It is especially used by saddlers and other workers in leather.

**Tack-driv'er.** 1. A tack-hammer.

2. A tool with devices for automatically presenting the tacks in succession, and driving them into place.

The example shows one which has an inclined plate serving as a hopper, by which the tacks fall into an inclined guide open at the bottom, which causes them to fall with their points downward. Two dies direct the tacks, and a slide forces a tack under the driver, which is held up by a spring. A stroke from a mallet on the driver sets the tacks in the place intended for them.

Fig. 6157.



*Tack-Driver.*

**Tack-ham'mer.** A small hammer used for driving and extracting tacks. The pein usually has either a thin edge, which may be inserted beneath the head of the tack, or is divided, to form a claw. In Fig. 6158 the claw is at the end of the handle.

Fig. 6158.

*Tack-Hammer.*

**Tack'ing.** 1. (*Metal-working.*) Uniting metallic pieces by drops of solder, to hold them in place until the solder is regularly applied to the joint.

2. Securing by tacks temporarily; as the pieces of a saddle or boot to the tree or last, to hold them in position for sewing.

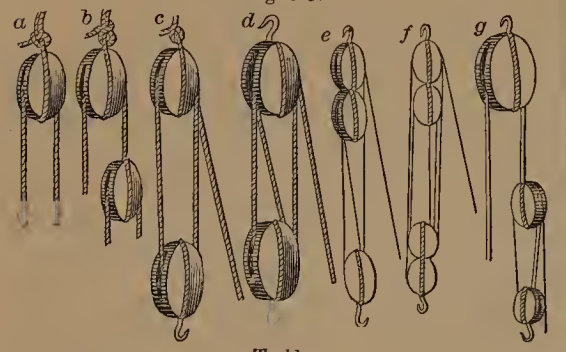
3. (*Nautical.*) Directing a vessel on to another tack when beating against the wind, so that the wind comes on the other bow.

**Tack'ing-mill.** A name of a kind of fulling-mill, *temp.* Edward IV.

**Tack'le.** An apparatus, or that part of an apparatus, by which an object is grasped, moved, or operated: as *gun-tackle*; *ground-tackle*; *fishing-tackle*; *plow-tackle*; *hoisting-tackle*; *reef-tackle*; *luff-tackle*; etc.

1. (*Nautical.*) A *simple tackle* consists of one or more *blocks*

Fig. 6159.




*Tackles.*

rove with a single rope. When two blocks are employed, one is the *standing block*, and the other the *running block*. The rope is termed the *fall*, and runs over the *sheaves*. The fast end of the *fall* is the *standing end*, the other the *running* or *hauling end*.

To *overhaul* a tackle is to separate the blocks by running out the rope.

*Fleeting* a tackle is to bring the blocks close together by hauling on the *fall*.

The block is bound with a *grommet* in the direction of its length. This is called the *strap*, and lies in the *score* of the block. If the strap be continued, so as to form a tail, it constitutes the block a *tail-block* or *jigger-block*. When a tackle has a *running block* of this character, it becomes a *jigger-tackle*.

As to kinds, the names founded upon structure: —

A *single whip* (*a*, Fig. 6159) is the simplest tackle. It consists of one *single* block and a fall. The standing block is made fast to a stationary object. The hook is applied to the load, and the power to the *fall*.

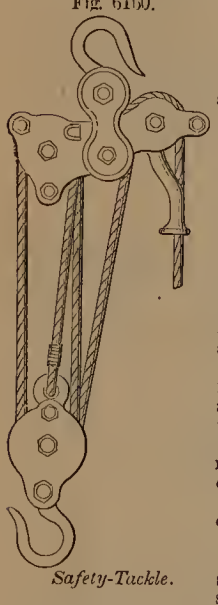
The *whip-on-whip*, or *whip-and-runner* (*b*), has two single blocks, one of which is a *standing* and the other a *running* block. The *fall* of the *standing* block is spliced round the block of the lower *whip*. The power is double that of a *single whip*.

The *double purchase*, or *gun-tackle purchase* (*c*), has two single blocks, the fall being rove through both, and the standing end being made fast to an eye on the bottom of the standing block.

The *reef-tackle* is a *double* purchase.

The *treble purchase*, or *luff-tackle purchase* (*d*), has a double and a single block, the fall being rove through one of the sheave-holes in the double block, then through the single block, then through the other sheave-hole in the double block, and is secured by splicing, or by an eye to the top of the lower block.

Fig. 6160.



*Safety-Tackle.*

The *yard-tackle* is a *treble* purchase.

A *twofold purchase* has two double blocks.

A *threefold purchase* has a *treble* block and a *double* one.

A *top-burton tackle* (*e*) is rove in the same manner as a luff-tackle purchase; the upper block of the burton is a fiddle-block, while that of the luff is a double one.

A *long tackle* (*f*) is composed of two long blocks, each of which resembles a pair of single blocks joined at their ends.

A *runner-tackle* (*g*) is the same purchase as a luff-tackle applied to a runner. A runner is a thick rope rove through a single block, and has usually a hook attached to one of its ends, and one of the tackle-blocks to the other; in applying it, the hook of the runner, as well as the lower block of the tackle, is fixed to the object intended to be removed.

The *garnet*-tackle is swung from the mainstay and used for getting boats or cargo on board or ashore.

The *jigger* is a block with a tail, for convenience of fastening it to an object.

A *tail*-block is also known as a *jigger*.

A *jeer* is a fourfold purchase used in swaying or striking the lower yard of a ship.

Fig. 6160 is a safety-tackle. To hold in suspension a load at any given elevation, a vibratory frame is hung in a suitable link of the stationary block, so that upon the cessation of pull upon the rope to raise the weight, the rope is swayed into a recess or gerge, and compressed there with a force proportionate to the weight. Upon the resumption of the pull upon the rope, it is swayed out of the recess, and the weight caused again to ascend.

As to kinds, the names founded upon place or purpose: —

*Boom*-tackle; used for rigging out or in the studding-sail booms, and consisting of a double and single block and fall.

*Bowline*-tackle; used to bowse out the main bowline.

*Fish*-tackle; one used in getting the anchor on to the gunwale.

*Ground*-tackle; anchors, cables, etc.

*Gun*-tackle; a purchase of two single blocks and fall, used for running guns in and out on shipboard.

*Luff*-tackle has a double and a single block and a fall. The *luff* is the weather leach of a sail.

A *pendant*-tackle is rigged from a pendant of the mast-head; used for hoisting cargo in or out of the fore or main hold, and for other purposes.

*Port*-tackle; used in tricing up the ports of the lower deck.

*Quarter*-tackle; used in hoisting aboard water, etc.

*Reef*-tackle; for rousing the reef-cringles of a sail up to the yard for reefing.

*Relieving*-tackle; a substitute for a disabled wheel and wheel-rope

*Rolling*-tackle; used to steady the yards in a heavy sea.

*Rudder*-tackle; hooked to the rudder-pendant, to save the rudder if unshipped.

A *side*-tackle is used in working a gun, being hooked to a bolt on the side of the carriage.

*Stay*-tackle; hooked to the *triatic stay*.

*Stock*-tackle; hooked to the anchor-stock to rouse it on to the bows.

*Tack*-tackle; to bowse down the tack of a sail.

*Top*-tackle; used in swaying up a topmast.

*Train*-tackle; used in running in a gun, or to prevent its running out while being loaded.

*Truss*-tackle; that by which the truss of a lower yard is bowsed taut.

*Winding*-tackle; a purchase used in hoisting heavy articles or cargo.

*Yard*-tackle; a hoisting-tackle swung from a lower yard.

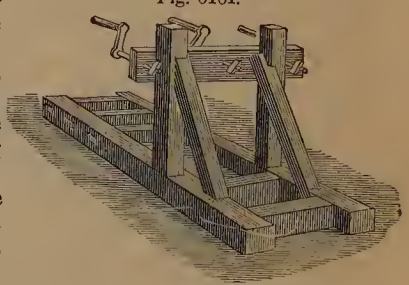
2. The appurtenances of a sport or work; as *fishing*-tackle, *plow*-tackle, *hoisting*-tackle, etc.

**Tack-leath'er-ing Ma-chine'.** A machine for attaching leather washers to carpet-tacks.

**Tack'le-block.** A pulley over which a rope runs. It usually consists of a sheave or sheaves in a shell. For varieties, see BLOCK; for applications, see TACKLE.

**Tack'le-board.** (*Rope-making.*) A frame at the head of a ropewalk containing the *whirls* to which *yarns* are attached to be twisted into *strands*. The *whirls* are also known as *winches* or *fore-lock hooks*, and there are generally three in a *tackle-board*, that being the number of *strands* which go to make a *rope*.

Fig. 6161.



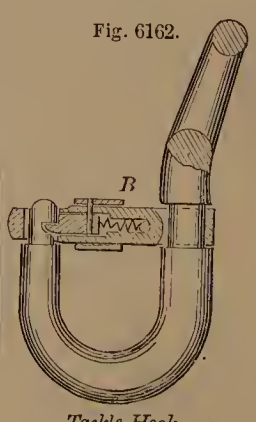
*Tackle-Board.*

By another arrangement, the three whirls are rotated by a master wheel, the axes of the pinions being prolonged into hooks, and the main wheel is worked by a crank.

**Tack'le-fall.** The rope which is rove through a block.

**Tack'le-hook.** The hook by which a tackle is connected to an object to be hoisted.

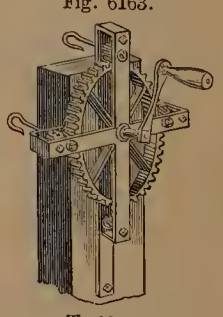
Fig. 6162.




*Tackle-Hook.*

The example is provided with a

Fig. 6163.



*Tackle-Post.*

mousing device *B* having an eye surrounding the shank of the hook, on which it has a motion both sideways and upward. An eye at the other end engages over the point of the hook, where it is held by a retractile spring-catch.

**Tack'le-post.** (*Rope-making.*) A post with *whirls* in a ropewalk, to twist the three strands which are laid up into a cord or rope.

**Tack'ler.** (*Mining.*) A small chain having a hook at one end and a ring at the other; four are made fast to the skip in order to hoist it up the shaft.

**Tack-pull'er.** A claw to draw tacks. A *tack-claw.* See TACK-HAMMER.

**Tack-tack'le.** (*Nautical.*) A purchase for hauling down the tack of a sail.

**Tac-tom'e-ter.** See ESTHESIOMETER; NERVE-NEEDLE.

**Tæ'ni-a.** (*Architecture.*) The band or fillet surmounting the Doric epistylium.

**Taffe-ta.** (*Fabric.*) A species of silken goods. See TAFFETY.

"Ashamed that she [Mrs. P] should be seen in a taffata gown, when all the world wears moyre" — PEPYS'S *Diary*, 1662.

**Taf'fe-ty.** (*Fabric.*) A rich, glossy silk stuff; plain, flowered, gold-striped, watered, or embroidered. The word is Persian.

**Taff'rail.** (*Shipwrighting.*) A transverse rail which constitutes the uppermost member of a ship's stern.

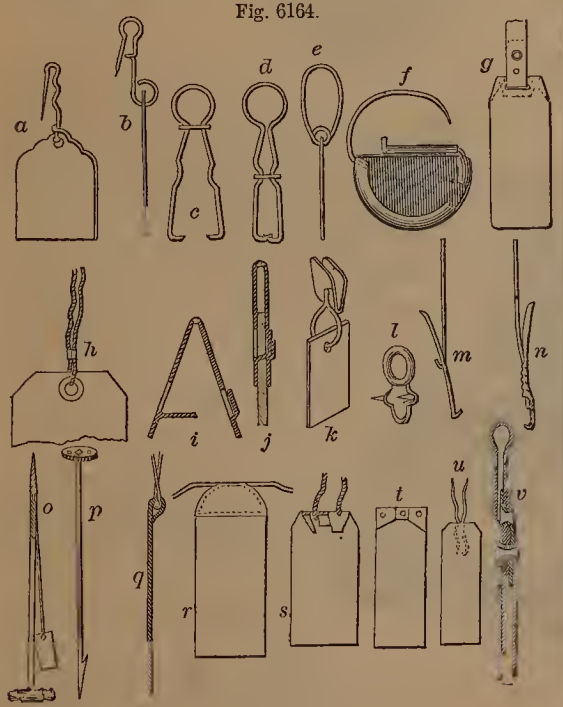
**Tag.** 1. A strip, having means of attachment to a bag or package, and on which an address may be written, printed, or stamped.

2. A metallic binding on the end of a boot-lace to stiffen and prevent raveling.

**Tag-fast'en-er.** A means of attaching a mark, tag, or label, to a bale, package, or other object or merchandise.

Fig. 6164 shows a number of different kinds
*a b* are bent hooks, with barbs or catches to prevent retraction.
*c d e* are wire clasps.
*f* is another form of clasp, with a metallic tag, in which the end of the bow locks.
*g h k* are tied or riveted
*i j* are two views of a plate which perforates and locks upon a tag.
*l* is an eye with riveting-spurs.

Fig. 6164.




*Tag-Fasteners.*

*m n o p* are arrow-shaped spikes to be driven into a cotton or hay bale to hold the direction-tag.
*q r s t u v* are tags of various kinds.

**Tag'ger.** A device for removing the tag locks from sheep.

**Tag'gers.** Sheets of tin or other plate which run below the gage of the box or bunch to which they belong, and are consequently set aside as light, and used for other purposes.

**Tag-hold'er.** A device to attach a card or direction to a bale, package, or trunk. See TAG-FASTENER.

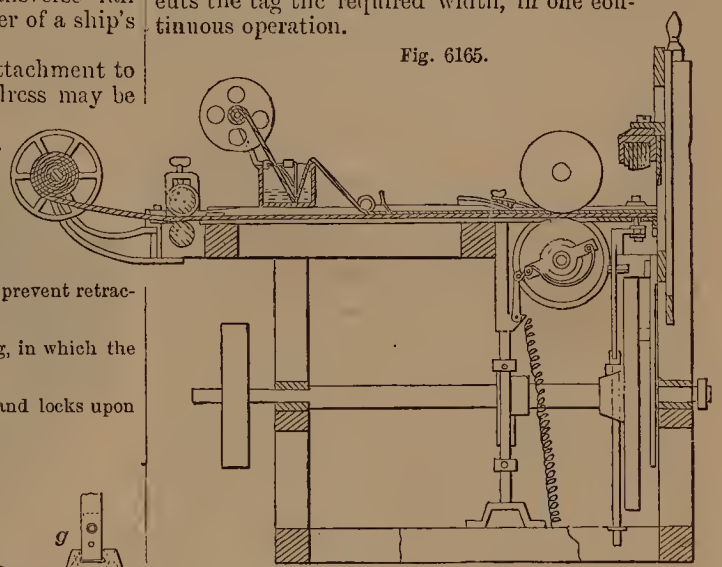
**Tagl'ia.** A certain system of pulleys, consisting of a set of sheaves in a fixed block, and another set in a movable block to which the weight is attached.

One cord goes around all the pulleys, one of its ends being fixed to a point in the system, and the other proceeding from one of the fixed pulleys drawn by the power.

Sometimes several are combined, so that one acts upon another, forming a compound taglia.

**Tag-mak'ing Ma-chine'.** The machine folds over the edge of paper required for the tag, inserts a tape, strips of fiber, or a cord, or both tape and cord at the same time; gums the fold down upon the tape, punches the eyelet, prints the address, and cuts the tag the required width, in one continuous operation.

Fig. 6165.



*Machine for Making Tags.*

**Tag-nee'dle.** A needle for securing tags to bales or bundles. The eye of the needle may be opened to the rear by so forcibly drawing the thread as to spring open the elastic piece which forms one side of the eye. See also NEEDLE, Fig. 3305; also *m*, *n*, *o*, *p*, Fig. 6164.

Fig. 6166.

*Tag-Needle.*

**Tail.** 1. The lower end of a slate or tile.

2. The end portion of a structure or work, as TAIL-BAY; TAIL-TRIMMER; TAIL-RACE (which see).

Fig. 6167.

*Tail-Block.*

3. (*Masonry.*) The end of a stone step which is inserted into the wall; such a step has usually a *tailing* of nine inches.

4. The reverse of a coin.

5. (*Nautical.*) A rope fastened to a block, and by which it may be lashed to an object. See TAIL-BLOCK.

**Tail-bay.** (*Hydraulic Engineering.*) That part of a canal-

lock between the tail-gates and the lower pond. See CANAL-LOCK.

**Tail-block.** (*Nautical.*) A block whose strap is prolonged into a tail, which is tapered, or the ends may be twisted into foxes and plaited together like a *gasket*. Blocks used for *jiggers* have a double tail, made in the same manner.

**Tail-board.** 1. (*Vehicle.*) The hind-end gate of a cart or wagon.

2. (*Shipbuilding.*) The carved work between the cheeks, fastened to the knee of the head.

**Tail-crab.** (*Mining.*) The capstan on which the spare rope of the crab is wound.

**Tail-gates.** (*Hydraulic Engineering.*) The lower pair of gates of a CANAL-LOCK (which see).

**Tai'lor-ing-ma-chine'.** A large sewing-machine adapted to a heavy class of goods. Several kinds of machines are made of such proportions as to adapt them to this work, and are illustrated under SEWING-MACHINE (which see).

The Wheeler and Wilson straight-needle machine is the "House" modification of the Wheeler and Wilson; preserving the Wilson feed, and the rotary hook in a modified form, in combination with a straight and vertically moving needle.

It differs from the ordinary Wheeler and Wilson, in having no *loop-check*, or other device for detaining the loop of the needle thread after it has been cast off the hook; it has an independent *take-up*, so that each stitch is completed before another is begun; its hook moves with a varying velocity, differing during each revolution from that of the main shaft, although it makes the same number of revolutions per minute. The needle is straight, and is driven by devices which cause it to pause entirely and move up and down with varying velocity at each stitch; the hook carries the upper thread around the bobbin, which contains the lower thread, interlocking the threads.

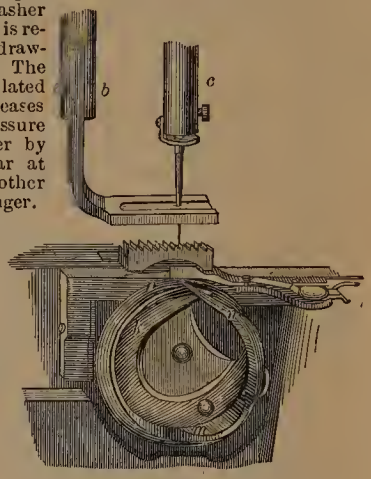
On the iron case is mounted the arm *a*, which holds the presser-bar *b* and the needle-bar *c*. The needle-arm *d* and take-up lever *e* are pivoted to the arm *a*, and actuated by cams on the main shaft beneath the iron plate forming the top of the case.

The upper or needle thread passes from the spool *f* along the bracket arm and by the thread-guide *g*, the tension-pulley *h*, the controller *i*, the jack *j*, over the front end of the take-up lever *e*, and through the eye of the needle. The lower thread is wound on the bobbin *B* (Fig. 6170), which is placed within the bobbin-case, and they are held in the cavity of the hook *k* by the ring-slide, the thread being drawn out in front.

In operating, the needle descends and thrusts a bight of the upper thread through the material, and then, rising to clear the hook-disk, it stands while the hook-point, having entered this loop, enlarges it by a quick motion, and carries it forward, at the same time the take-up descends and gives out the upper thread, which is drawn through the eye of the needle below the fabric. A half-revolution of the hook having now been quickly made, and the loop cast off over the bobbin (see *A*, Fig. 6170), and the needle, being entirely out of the material, the take-up rises quickly and draws up the loop. At the moment of drawing up the stitch, the apparatus for securing and regulating the under tension comes into play. A part of the hook-washer projects over the hook, and at each revolution presses upward against a bar attached to the frame of the machine. Through a hole in this bar (called the tension-finger) the lower thread passes.

While the stitch is drawing up, as soon as the loop has passed through the tension-finger, the under thread is clamped between the hook-washer and tension-finger, and is released as soon as the drawing up is completed. The under tension is regulated by a lever, which increases or diminishes the pressure upon the hook-washer by being brought to bear at will upon one or another point of the tension-finger.

Fig. 6169.



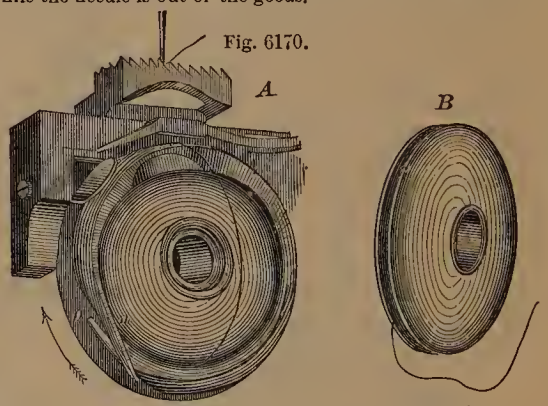

*Hook and Feed, without Bobbin.*

The thread is drawn through the needle while it is out of the material, giving it an advantage in sewing leather and starched fabrics with a small needle.

The presser-foot may be flat or a wheel, and is hinged or attached by a set-screw to the presser-bar.

In the Wheeler and Wilson family machine, the loop of one stitch is drawn up through the agency of the rotary hook in expanding the loop for the next stitch. In the House machine, each stitch is completed separately, the drawing up being done while the needle is out of the goods.

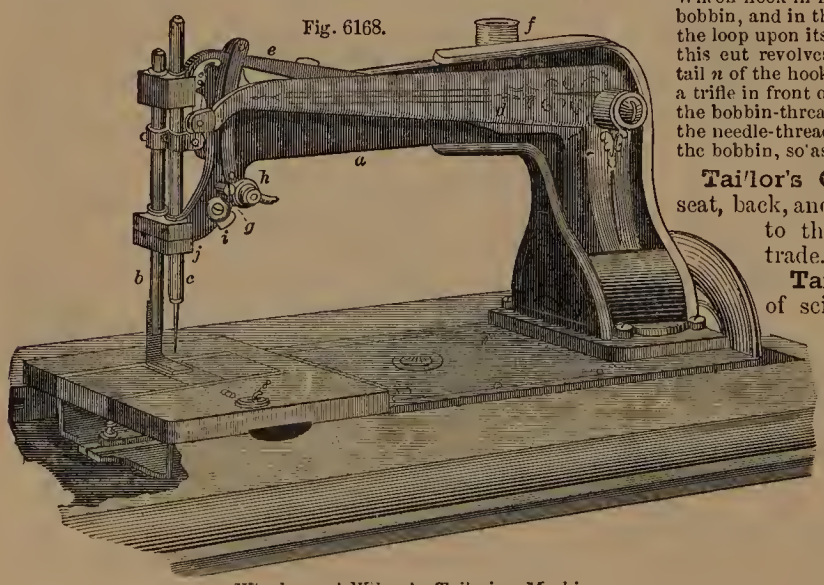
Fig. 6170.




*Hook and Bobbin.* *Bobbin.*

The rotating-hook differs from the ordinary Wheeler and Wilson hook in having a deeper cavity for the thicker bobbin, and in the cut *m*, which gives free course to the loop upon its being cast off and drawn up just as this cut revolves to the needle (*A*, Fig. 6170). The tail *n* of the hook overlapping the point *p* of the hook a trifle in front of it, acts as a guard in keeping off the bobbin-thread while the hook enters the loop of the needle-thread. It also draws a little thread from the bobbin, so as to leave it slack for free play.

Fig. 6168.




*Wheeler and Wilson's Tailoring-Machine.*

**Tai'lor's Chair.** A legless chair, with seat, back, and knee-rest (Fig. 6171), adapted to the cross-legged position of the trade.

**Tai'lor's Shears.** A large style of scissors used in cutting woolen goods.

In the example (Fig. 6172), the upper blade and handle move upon a slotted fulcrum, which gives a *draw* cut. The edges are kept in contact by a spring. See also SHEARS; SCISSORS.

**Tail-piece.** 1. (*Lathe.*) The set-screw of the rear lathe-spindle.

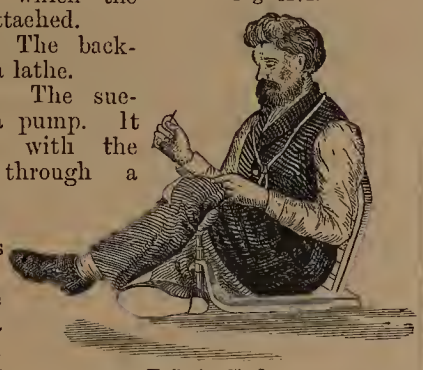
2. (*Music.*) The block of a violin, guitar, or similar in-

strument, to which the strings are attached.

**Tail-pin.** The back-center pin of a lathe.

**Tail-pipe.** The suction-pipe of a pump. It communicates with the pump-stock through a clack-valve, and in the case of metal pumps is in two parts, the upper one of which has a screw-thread at its lower end, by which it is secured to the lower part, the latter being cut to a suitable length.

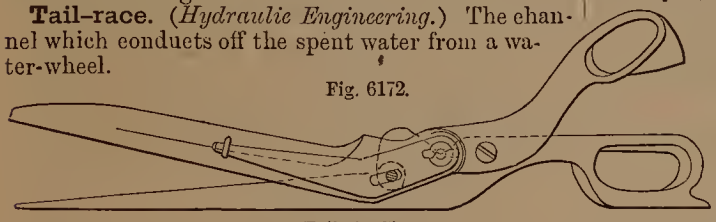
Fig. 6171.



*Tailor's Chair.*

**Tail-race.** (*Hydraulic Engineering.*) The channel which conducts off the spent water from a water-wheel.

Fig. 6172.



*Tailor's Shears.*

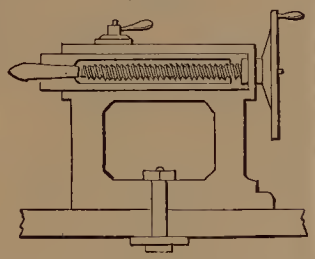
**Tail-screw.** (*Lathe.*) The screw which advances or retracts the back center.

In the commoner description of lathes the back center is at the end of the tail-screw, but in superior lathes the center is formed on a plug

Fig. 6173.

*Tail-Pipe.*

Fig. 6174.



*Tail-Screw.*

fitted in the end of a plunger, which is simply advanced and retracted in the barrel of the tail-stock by the rotation of the screw. The back center is held to its adjustment by the set-screw above.

**Tail-stock.** (*Lathe.*) That head of a lathe which contains the non-rotating spindle, called the *dead-spindle*. At the other end of the lathe is the *head-stock*, in which is the *live-spindle*. The *tail-stock* is also called the *dead-head*, as containing the *dead-spindle*. See LATHE.

**Tail-tack'le.** (*Nautical.*) A luff-tackle, with a hook in the end of the single block, and a tail to the upper end of the double block. A *watch-tackle*. See TAIL-BLOCK.

**Tail-valve.** (*Steam.*) *a.* An air-pump valve in one form of condenser, opened by the steam entering the condenser, but closed by atmospheric pressure when a partial vacuum exists in the condenser.

*b.* The *snifting-valve* of a marine steam-engine.

**Tail-wa'ter.** The waste water discharged from the buckets of a water-wheel in motion.

**Tain.** 1. Thin tin plate. *Taggers.*

2. Tin-foil for mirrors.

**Take.** (*Printing.*) A portion of copy taken by a compositor at one time.

**Take-horse.** (*Mining.*) A vein of ore is said to *take horse* when it divides on each side of a body of non-metalliferous rock, called *dead-ground.*

**Take-up.** 1. (*Weaving.*) That motion of the cloth-beam in a loom by which the web is wound up as fast as the weaving proceeds. The *let-off* is the paying off of the yarn from the beam, and proceeds coincidently with the take-up. See LET-OFF.

2. (*Steam Navigation.*) The part between the smoke-box and the bottom of the funnel of a steamship.

3. (*Sewing-machine.*) A device in a sewing-machine to draw upon the upper thread to *take up* its slack while the needle is rising, or resting at its highest point, to tighten the stitch. The *independent take-up* is one which acts in its own time without being actuated by the needle-bar.

**Tal'bo-type.** (*Photography.*) A process invented by Fox Talbot, in which paper was sensitized by iodide of silver and exposed in the camera. The surface became the recipient of a latent image, which was developed, and was fixed by hyposulphite of soda. It was named by its originator, CALOTYPE (which see). It is the basis of the present photographic process. See PHOTOGRAPHY.

**Talc.** A mineral which occurs in granular and flaky conditions; a silicate of magnesia, or of magnesia and alumina; usually with the addition of iron. See Dana's "Mineralogy," ed. 1868, pages 452, 453.

The *massive* is known as *steatite*, *soapstone*, or *potstone;* the foliated approaches the character of mica, from which it is hardly distinguishable. The distinguishing test is that the thin laminæ of *talc* are flexible but not elastic; *mica* is very elastic.

*Asbestus*, or *amianthus*, is another closely allied mineral, occurring in many forms, the most characteristic of which is fibrous. See ASBESTUS.

*Soapstone* is used in slabs for stoves, and when powdered in composition for porcelain and for crayons.

**Tal'i-pes-ap'pa-ra'tus.** Club-foot is produced by eversion, inversion, or retroversion of the foot; and is known as *Talipes Valgus*, *Varus*, or *Equinus*. See CLUB-FOOT APPARATUS.

**Talk'ing-ma-chine'.** An acoustic instrument in which articulate differences of sound are produced. Kempelen and Willis gained celebrity in this line.

Wolfgang von Kempelen, the inventor of the so-called automaton chess-player, which was only an ingenious deception, contrived a talking head, which contained wind-tubes and vibrating reeds, the latter set in motion by a bellows in the bust. The capacity of the machine was limited, but the following words and sentences were automatically enunciated without the intervention of a person to touch any keys: *opera; astronomy; Constantinople; vous êtes mon amie; Romanorum imperator;* etc. Tubes to imitate nostrils produced "*m*" and "*n*"; a funnel and a reed changed "*s*" into "*z*," "*sch*," and "*j*" Parts of the mechanism imitated the movements and action of the mouth, lips, teeth, tongue, palate, glottis, lungs, etc.

Faber's machine gives the correct pronunciation of the letters and elementary sounds, and enunciates phrases of six or eight words in the English, French, and German languages. Air is forced by a bellows, through a narrow aperture, into an iron windpipe, and thence into an artificial glottis, from whence it passes through a vent representing the human mouth, with movable jaws and a rubber tongue. Pipes and rubber tubes, operated by fourteen levers, are arranged to produce the various

Fig. 6175.

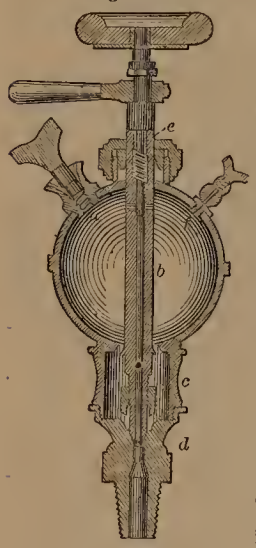
*Tallow-Can.*

sounds. The voice is shrill, monotonous, and unnatural, but in a majority of instances strikingly correct. Laughter is caused by a separate lever.

**Tal'low-can.** A vessel to hold melted tallow for lubricating purposes.

**Tal'low-cup.** A lubricating-device for journal-boxes, etc., in which tallow is employed as the lubricant.

Fig. 6176.




*Tallow-Cup.*

In that illustrated, the tallow is introduced through the aperture *a*, and steam admitted through the hollow valve-stem *b*; this melts the tallow, and when the upper valve is open, as shown, forces it down into the lower part *c* of the cup. On raising the stem, the upper valve is closed and the lower one *d* is opened, permitting the tallow to flow on to the part to be lubricated, the steam-opening in the valve-stem being closed by means of the screw-threaded rod *e*. *f* is the steam-escape opening.

**Tal'ly.** A notched stick employed as a means of keeping accounts.

Tally-sticks were used in ancient Egypt; one is in the Abbott Museum, New York. They were also employed by the Athenians.

In England they were long issued in lieu of certificates of indebtedness to creditors of the state. In 1696, according to Adam Smith, this species of security was at 40 to 60 per cent discount, and bank-notes 20 per cent.

Besides accounts, other records were formerly kept upon notched sticks, as almanacs, in which red-letter days were signified by a large notch, ordinary days by small notches, etc. Such were formerly common in most European countries. The Runic Clog-Almanack and the Saxon Reive Pope are of this class, and yet exist in Sweden, and in Staffordshire, England.

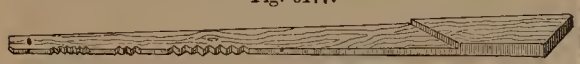
Somewhat similar was the ancient Briton *Coelbren y Beirdd*, the "billet of the signs of the bards."

The mode of keeping accounts by tallies was introduced into England by the Normans, 1066.

Seasoned sticks of willow or hazel were provided, and these were notched on the edge to represent the amount.

Small notches represented pence; larger, shillings; still larger, pounds; proportionately larger and wider, were 10,

Fig. 6177.



*Exchequer Tally.*

100, 1000 pounds. The stick being now split longitudinally, one piece was given to the creditor, and the other was laid away as a record. When an account was presented for payment, the voucher was compared with the record.

When paid, the *tally* and *counter-tally* were tied up together and laid away, accumulating for a long series of years. The history of the final abandonment of the system, and the catastrophe to which the disposition of this accumulation of rubbish led, is related by Charles Dickens, in a speech in favor of political and official reforms: —

"Ages ago a mode of keeping accounts in the Exchequer, by means of notched sticks, was introduced. In the course of time the celebrated Cocker was born and died; then Walkinghame, the author of the 'Tutor's Assistant'; then a multitude of accountants, actuaries, and mathematicians, who discovered and published means of account-keeping by ordinary arithmetic, far more ready, and which, in their every-day transactions, everybody used; but official routine looked upon these notched sticks as a part of the Constitution, and the Exchequer accounts still continued to be kept by these willow tallies. But, toward the end of the reign of George III., it occurred to some innovating and revolutionary spirit to suggest the abolition of this barbarous custom, and immediately all the red tape in all the public departments turned redder at the idea of so bold a conception; and it was not until the year 1826 that the custom of keeping these Exchequer accounts by willow tallies ceased. In 1834 it was found that a large accumulation of these tallies had grown up in the course of time, and the question arose what was to be done with these old worm-eaten, useless bits of wood.

"They were housed at Westminster. Common-sense would have suggested that they should be given for firewood to some of the poor miserable people who abounded in that neighborhood; but official routine could not endure that, and accordingly an order was given that they should be burned privately. They were burned in a stove in the House of Lords; but the stove being overheated by them set fire to the paneling of the room, the paneling set fire to the House of Lords, the House of Lords set fire to the House of Commons, and the two houses were reduced to ashes."

See also Clark's Commentary on Revelations ii. 17. See also BALLOT; ABACUS; ARITHMOMETER.

**Tal'on.** 1. (*Architecture.*) A form of molding, the same as OGEE (which see).

2. (*Locksmithing.*) The shoulder on the bolt against which the key presses in *shooting* the bolt.

**Ta'lus.** A slope: —

1. Of an embankment or earthwork in civil or military engineering.

2. Of a wall having a battering face.

3. A sloping heap of fragments at the base of an escarpment.

**Ta'lus-wall.** (*Masonry.*) A wall inclined on its face, either by decreasing its thickness toward the summit or by leaning it against a bank, as a *retaining* or *breast wall.*

**Tam'bour.** 1. (*Fabric.*) A species of embroidery in which threads of gold and silver are worked by needles in figures of leaves and flowers upon a silk stuff stretched over a circular frame, called a *tambour-frame.* This resembles a drum-head, and thus acquired its name. French *tambour*, "a drum."

2. A DRUM (which see).

**Tam'bour-ine'.** (*Music.*) An instrument of percussion, resembling a shallow drum with one head, and surrounded by small bells.

It is also known as the *tambour Basque*, and is a favorite instrument of the Italian peasants, the gypsies, and Basques. It is played in three ways: by striking; by rubbing its parchment with the ends of the finger, which gives a tremulous sound, and a jingling of the bells in the edge; by continuous rubbing with the thumb, which gives a wild, trembling sound.

The peculiar song of some insects, as the katydid, is produced in an analogous manner by the rubbing together of their wings.

On a sculpture at Dendera, in Egypt, is shown a musician playing on the tambourine. The Egyptian mode of playing was similar to the modern; and from the position in which it is held after striking, it is thought to have had the same tinkling disks in the rim. Among the ancient Egyptians its shapes were very various.

Fig. 6178.

*Tambourine.*

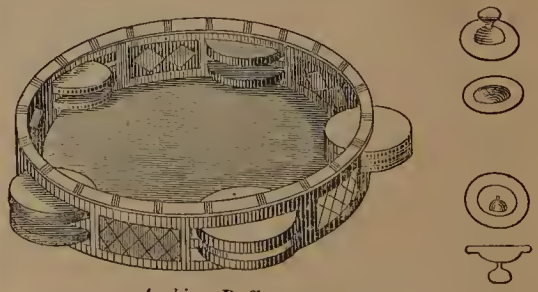
The *timbrel* of Miriam, the priestess, and sister of Moses and Aaron, was, no doubt, an Egyptian instrument. She and her attendants played on timbrels and sang the antiphone to the song of Moses and the congregation.

She "took a timbrel in her hand, and all the women went out after her with timbrels and with dances."

The ladies are now excluded from participation in Hebrew religious rites. The *tabret*, or *timbrel*, probably resembled the dasabooka of the Arabs, — a sort of *tam-tam*, or hand-drum; the *tympanon* of the Greeks.

Euripides celebrates "the skin-stretched circle of the tambourine of Phrygia, of the great mother Rhea."

Fig. 6179.



*Arabian Deff and Castanets.*

The modern Arabian *deff* does not differ materially from the European. It has a number of tinkling disks of metal set in slots in the rim, and is played by thrumming and shaking.

The name is derived from the Arabic *altambor*, and immediately is the diminutive of the French *tambour*, being considered a shallow drum with one head.

**Tam'ine.** Woolen cloth; *tammy*. Sometimes synonymous with *tawney*.

**Tam'is.** (*Fabric.*) *a*. A thin woolen stuff, highly glazed. *Taminy*.

*b*. A strainer or bolter.

**Tam'my.** (*Fabric.*) A glazed worsted cloth used for ladies' gaiters; also for a straining cloth.

**Tamp'ing.** 1. (*Smelting.*) Stopping with clay the issues of a blast-furnace.

2. (*Military Mining.*) Packing with earth, sandbags, etc., that part of the mine nearest to the charge to increase its effectiveness in a given direction.

3. (*Blasting.*) *a*. Filling up a blast-hole, above the charge, so as to direct the force of the explosion laterally and rend the rock.

*b*. The material used for the above purpose; it may be fragments of stone, earth, sand, or even water.

Lieutenant-General Sir John Burgoyne, of the English Engineers and Inspector of Fortifications, states that the desideratum in tamping is to obtain the greatest possible resistance over the charge of powder; if it could be made as strong as the rock itself, it would be perfection.

*a*. The different materials employed for tamping are: —

The chips and dust of the quarry itself. This is what is most commonly used, unless there be stone in it that strikes fire.

*b*. Dry sand poured in loose, or stirred up as it is poured in, to make it more compact.

General Burgoyne cites the favorable notice of sand in this connection, in the memoir of the works at Cherbourg, and also by a writer in the Journal of the Franklin Institute.

He also cites the experience of General Pasley, of the English Engineers, who condemns sand as utterly unfit.

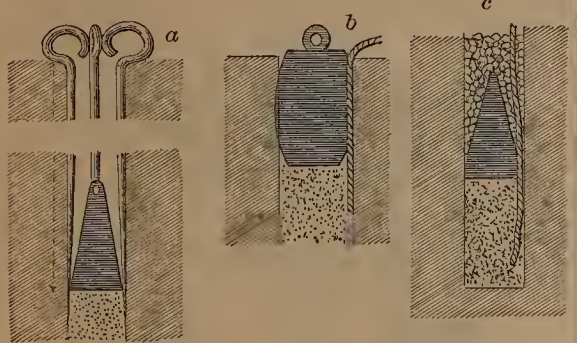
An extended series of experiments were made in the granite of Dalkey, Kingstown Harbor, Ireland, in which sands of various qualities and fineness were tried, as against the baked clay. The results of the experiments were all unfavorable to the sand.

*c*. Clay, well dried, either by exposure to the sun or by a fire.

*d*. Broken brick. It is used in small pieces and dust, and is improved by being slightly moistened with water during the ramming. It is pronounced inferior to the dried clay.

Several mechanical devices to assist in tamping have been suggested. The evident one would be a mere plug of a tapering shape, and driven into the hole. The most satisfactory of these devices has been an iron cone, with arrows around it, driven in as wedges. Another plan is a barrel-shaped plug, with a groove for the passage of the fuse. In a third instance, the iron cone was secured by tamping above it.

Fig. 6180.




*Tamping Cones and Plug.*

*a*, tamping-cone. *b*, tamping-plug. *c*, tamping-cone.

**Tamp'ing-bar.** (*Blasting.*) A bar of copper, brass, or wood, used in driving the *tamping* upon the charge in a blast-hole. Iron is to be avoided, as it sometimes strikes fire against a flinty or gritty piece of the tamping. See BLASTING-TOOLS.

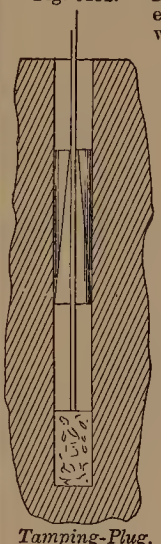
**Tamp'ing-ir'on.** A tool, prudently made of copper, by which the *tamping* is wadded down upon the cartridge or charge in a hole, for blasting. It is sometimes called a *driver*. A *tamping-bar*.

**Tamp'ing-ma-chine'.** (*Pipe-making.*) A machine for packing clay or the material for artificial stone into a mold. See STONE-PIPE MACHINE.

**Tamp'ing-plug.** A stopper for a hole in which a blasting-charge has been placed. It usually consists of a cone with barbs, or of a set of wedge-shaped blocks, which jam by the pressure from beneath.

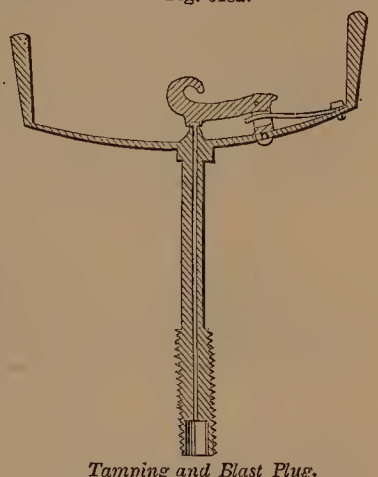
Fig 6182 is a tamping and blast plug, for splitting logs and stumps. The barrel is inserted into an auger-hole in the wood, and the contained charge exploded by drawing off the spring-hammer with a cord.

Fig. 6181.



*Tamping-Plug.*

Fig. 6182.



*Tamping and Blast Plug.*

**Tam'pon.** (*Surgical.*) A plug or stopper, of rag, sponge, etc., used in stopping hemorrhages.

**Tam'-tam.** *a*. The Oriental drum, consisting of a gourd covered with a lizard's skin.

*b*. A Chinese gong.

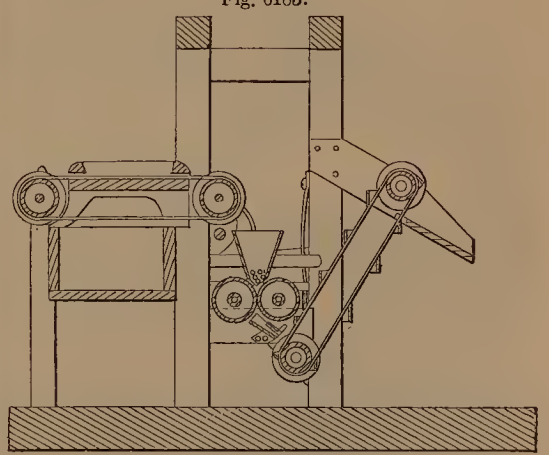
The composition, according to Klaproth, is, —

| | |
|---|---|
| Copper | 78 |
| Tin | 22 — 100 |

It is cast, and then tempered by being plunged, while hot, into cold water. The effect is the reverse of that with iron, as the metal is less brittle, and will bear the hammer.

The action of the hammer is to put the metal on a strain, the head having a tension like that of a drum.

Fig. 6183.



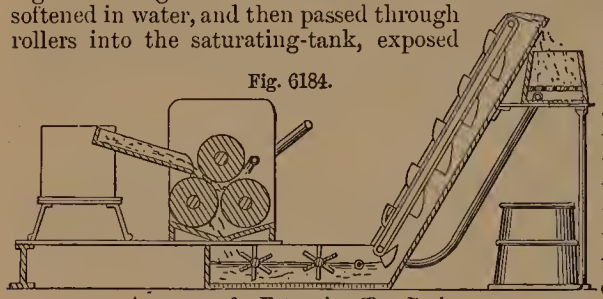
*Apparatus for Desiccating Leached Tan.*

**Tan-bark Des'ic-ca'tor.** A machine for drying leached tan-bark. It has an endless apron passing through a hopper placed over the leaching-trough, which carries the leached bark to another hopper, the latter feeding it between two hollow heated rollers which express the liquid.

**Tan-ex-tract'or.** A leaching device for extract-

ing the astringent matters from bark. The bark is softened in water, and then passed through rollers into the saturating-tank, exposed in said tank to the action of beaters, elevated and passed through a series of leaches, where it is washed repeatedly until all the astringent properties contained therein are taken up by the wash.

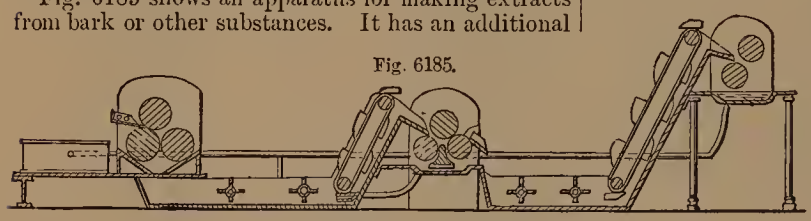
Fig. 6184.



*Apparatus for Extracting Tan-Bark.*

Fig. 6185 shows an apparatus for making extracts from bark or other substances. It has an additional or secondary tank and two sets of squeezing-rollers combined with the crushing-rollers, saturating-tank, and elevator, so that the astringent qualities will be disengaged and the pulp left finally in a condition to be used as fuel.

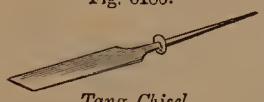
Fig. 6185.



*Apparatus for Making Extracts.*

**Tang.** The shank of a knife, chisel, file, etc., which is inserted in the haft.

Fig. 6186.

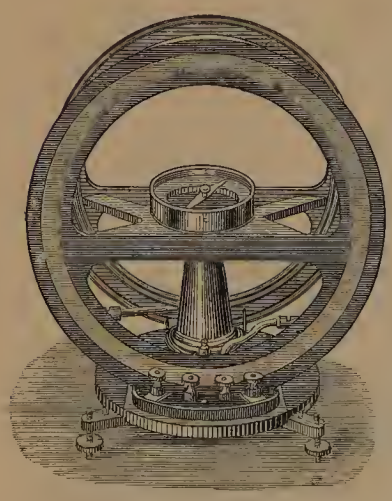


*Tang-Chisel.*

**Tang-chis'el.** A chisel with a tang for insertion in a handle; in contradistinction to a socket-chisel, which has a hollow tang to receive the handle.

**Tan'gent-gal'va-nom'e-ter.** One in which the length of the astatic needle employed is so short, in comparison with the diameter of the surrounding copper ring through which the current to be measured is passed, that the intensities of currents may be regarded as proportional to the tangents of the angles of deflection of the needle. The tangents in this case serve as a direct measure of the comparative intensities.

Fig. 6187.



*Tangent-Galvanometer.*

Fig. 6187 represents Gaugan's instrument, in which two conducting rings are employed, the needle, in a case provided with a graduated circle, being supported centrally between them.

**Tan'gent-scale.** (*Ordnance.*) A species of breech-sight for cannon. Its base has a curvature corresponding to the circumference of the breech of the gun, and its face is cut into steps corresponding to angles of elevation. The proper hight for each step is found by multiplying the natural tangent of the elevation in degrees by the distance between the base-ring and muzzle-sight. In using the scale, the required vertical line is brought to coincide with a longitudinal line at the upper part of the breech, and the top of the front-sight is viewed over the center of the step, the breech being raised or lowered until the face of the step and top of the front-sight are in the same horizontal plane.

Fig. 6188.

*Tangent-Scale.*

**Tan'gent-screw.** An endless screw tangentially attached to the index-arm of an instrument of precision, enabling a delicate motion to be given to the arm after it has been clamped to the limb, and permitting angular measurements to be made with greater exactness than could be done were the movement entirely effected by hand.

**Tan'gles.** (*Nautical.*) A device used in dredging, for sweeping the sea-bed for obtaining delicate forms of marine life, too small or frangible to be obtained by ordinary dredging. The tangles, in a coarse form, has long been used in the sponge and coral fisheries.

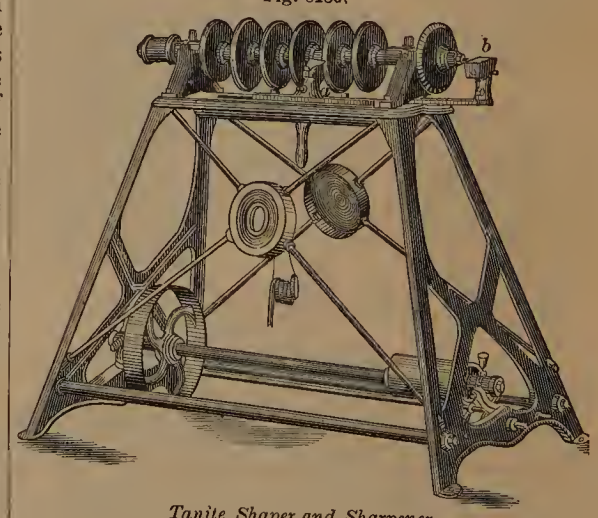
It consists of a bar 3½ feet long, supported on runners, and serving to drag after it a series of masses of hemp, each of which is a sort of mop. The fibers of the hemp entangle the smaller crustaceans and many of the more minute and delicate forms of marine life without breaking or injuring them as the dredge is apt to. Chains which are wrapped in the hempen swabs by their weight serve to keep the latter down to the work. Starfishes and sea-urchins, being prickly, are most readily caught by the tangles; in frequent instances immense masses of them are thus swept up and brought to the surface. See TRAWL.

**Ta'nite.** The trade name of a cement of emery and some binding material, used as a compound for grinding wheels, disks, laps, and in other forms.

**Ta'nite-shap'er.** A device for shaping and sharpening molding-bits, cutters, saws, and other wood-working tools.

It has a set of six emery-wheels, running between journals, and one overhung-wheel, all turning on a common spindle. The rest *a* may be fixed so as to work on either side of the table,

Fig. 6189.




*Tanite Shaper and Sharpener.*

or transversely thereto, and the rest *b* is adjustable to grind any desired bevel upon the overhung-wheel. The latter is specially intended for sharpening and gumming saws.

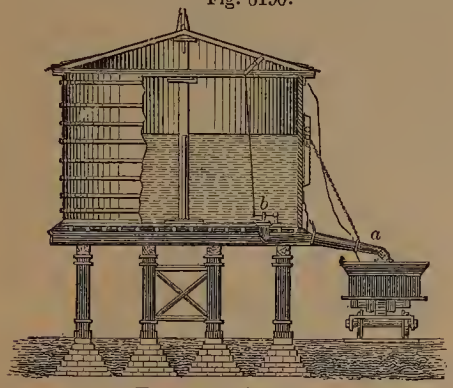
**Tank.** A vessel of large size to contain liquids.

1. (*Railroading.*) *a.* That part of a tender which contains the water. The tank varies in size, according to the power of the engine, and is from 500 to 1,600 gallons in capacity. See LOCOMOTIVE.

*b.* A reservoir from which the tank of the tender is filled.

Tanks for supplying locomotive-tenders with water are, when practicable, erected alongside of the track. They are generally made of wooden staves, like a large cask or tun, and supported

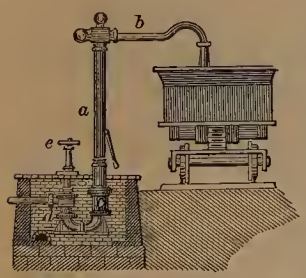
Fig. 6190.




*Elevated Railway-Tank.*

on a framework of wood, or upon a foundation of masonry. In Fig. 6190 the water flows into the tank from a stream or pond at a higher level, or is forced up by a pump, and is conducted by a spout *a* directly into the man-hole of the tender. The spout is usually attached to the tank by a hinged joint, so that it may be lowered to supply the water to the tender and then lifted out of the way of the engine and train. It is usually counterbalanced by a weight attached to a rope leading over a pulley at the upper part of the tank. A valve *b*, operated by a rope easy of access to the engineer, permits the water to flow when it is raised, and closes by its gravity.

Fig. 6191.




*Water-Crane.*

When there is no room for the tank near the track, it is placed in any convenient position at some distance from it, and the water conveyed by a pipe to a water-crane (Fig. 6191) located at the station. This consists of a vertical pipe *a*, with a horizontal branch *b* arranged to be swung around over the man-hole of the tender. It is preferable to have both pipes turn upon a joint at *c*, below the surface of the ground, as there is then less risk of freezing. The water is cut off at pleasure by a valve *d* operated by a hand-wheel *e*.

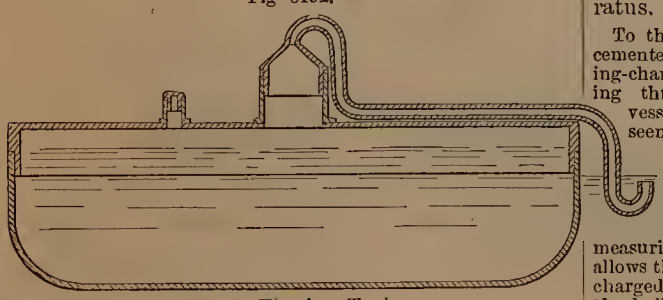
2. (*Nautical.*) Tanks for ships' use should be of galvanized sheet-iron; are usually rectangular in plan, four feet square, and from four to six feet deep. They hold from 400 to 600 gallons. A gallon is .1604 of a cubic foot. They are stowed at the bottom of the hold on a skeleton floor. Each has a man-hole in the top, and its shape is adapted to the part of the hold which it is intended to occupy.

3. (*Petroleum.*) The large development of the petroleum industry has given rise to various tanks, particularly designed for that class of oils which, in consequence of their combustible character, require particular care for their safe keeping. See OIL-TANK, page 1558.

Some of the larger tanks for the storage of petroleum partake of the character of cisterns beneath the ground or floating in water. The main effort of ingenuity has been to prevent access of fire to the contents.

Moody's tank (Fig. 6192) has a dome upon its top from which extends a tube which terminates under water. By this means direct communication between the interior of the tank and the open air is avoided. See also OIL-TANK, Figs. 3386–3394.

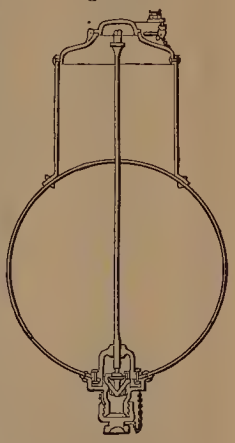
Fig. 6192.



*Moody Floating-Tank.*

Fig. 6193 shows the arrangement of Snyder's oil-tank for transportation; the valve-rod comes up through the dome to the level of the locked cover of the dome. See TANK-CAR; OIL-CAR.

Fig. 6193.



*Snyder's Oil-Tank.*

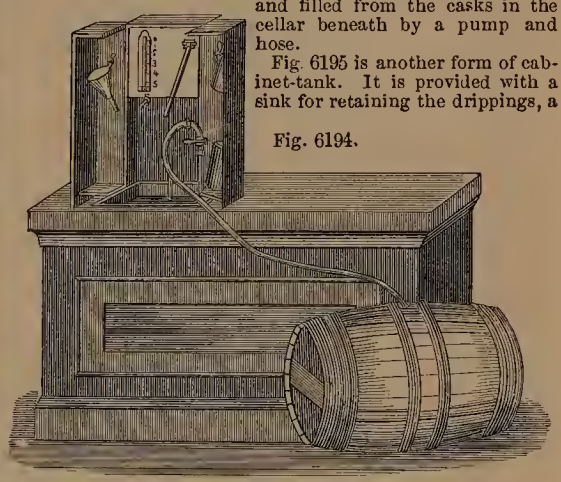
4. The term *tank* is also applied to a chamber or vessel in which a liquid is stored for dispensing or occasional use, as with oil, molasses, vinegar, wine, spirits, and other articles kept in stock, for sale in measured quantities.

Some of these are so large that the liquid may be dipped out, but usually it is drawn by a pump, as in Fig 3370, page 1547, or by a faucet, as in Fig. 3385, page 1557. See OIL-CAN; OIL-TANK, in which three cuts occur.

Fig. 6194 illustrates the "cabinet" oil-tank, for stores, workshops, etc. It may be placed on an upper floor of a building and filled from the casks in the cellar beneath by a pump and hose.

Fig. 6195 is another form of cabinet-tank. It is provided with a sink for retaining the drippings, a pump, and a gage-rod, by which any shortage may be readily detected when the contents of a barrel or other vessel are emptied into it.

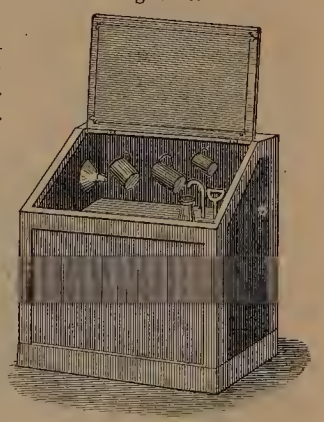
Fig. 6194.



*Oil-Tank.*

5. (*Soda-water.*) A vessel used in measuring and dispensing sirups in soda-water apparatus.

Fig. 6195.

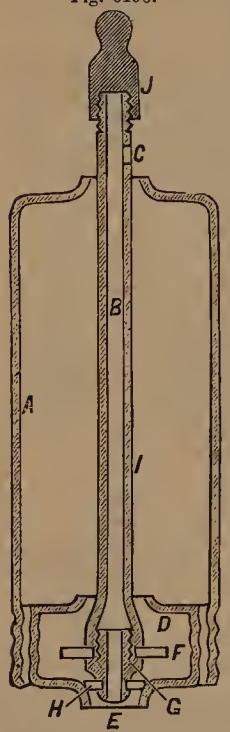


*Oil-Cabinet.*

To the glass vessel *A* is cemented a glass measuring-chamber *D*. The opening through which the vessel is charged is not seen in the drawing. When the rod is lifted by the handle *J*, the rubber *F* closes the upper opening in the measuring-chamber *D* and allows the liquid to be discharged at the opening *E*, the hollow rod *B* and its

opening *C* serving as a vent for air to enter. When the rod is dropped, the washer *H* closes the opening *E*, and the chamber *D* again fills, the air in the measuring-chamber passing into *A* and collecting above the sirup. The rod *B* is of hard rubber or wood, as the sirup is not allowed to come in contact with metal.

Fig. 6196.




*Matthews' Sirup-Tank.*

6. (*Gas.*) The cistern of a gas-holder, in which the lower edge of the inverted chamber is beneath the water-surface, forming a *seal* for the gas. See Fig. 2178, page 951.

**Tank'ard.** A large drinking-cup; or a covered pitcher from which wine is poured into cups.

Properly, a large drinking-vessel, from which persons drank in succession, passing it around the table. In classical times, and during the Middle Ages, it was a mark of intimacy to drink in this way, and a mark of condescension or politeness, as the case might be, on the part of the head of a feast to offer it. Not like the equally festive but less familiar *wassail-bowl*, from which the negus, or punch, was ladled

"At wakes and wassails."

Ourselves do well remember the *loving-cup* with which the worshipful master pledged his guests and his lodge, and then, wiping the brim, laid the napkin in the handles, and passed it to the next, and so on around the table.

The *peg-tankard* seems to have been ordered by Edgar, a man of little merit, and not strong in the head any way: pins in the wooden tankard divided the drinks. "Betsy, wotever you do, drink fair."

The canons allude to it: —

"Ut presbyteri non eant ad potationes, nec *ad pinnas* bibant."

As the tankard held two quarts, and there were eight pins, the allowance was near half a pint to each, which might do if the brew were stiff. The moral was not very evident, for if any one went beyond the pin he was obliged to drink again. A fine tankard at Wardour Castle has on the lid the Virgin and St. John, one on each side of the cross, and the twelve apostles round the cup. Worshipful company.

"Of drinking-cups, divers and sundry sorts we have, some of elme, some of box, some of maple, some of holly, &c. Mazers, broad-mouthed dishes, noggins, whiskins, piggins, crinzes, ale-bowles, wassel-bowles, court-dishes, taukards, kannes, from a pottle to a pint, from a pint to a gill. Other bottles we have of leather, but they are most used amongst the shepheards and harvest people of the Country; small jacks we have in many alehouses of the citie and suburbs, tipped with silver, besides the great black-jacks and bombards of the court, which when the Frenchmen first saw they reported at their returne into their Countrey that the Englishmen used to drinke out of their bootes; we have besides cups made of hornes of beasts, of cocker uuts, of goords, of the eggs of ostriches; others made of the shells of divers fishes brought from the Indies and other places, and shining like mother of pearle. Come to plate, every taverne can afford you flat bowles, beakers; and private householders in the citie, when they make a feast to entertaine their friends, can furnish their cupboards with flaggons, tankards, beere-cups, wine-bowles, some white, some percell guilt, some guilt all over, others without of sundry shapes and qualities." — Heywood's *Philo-cathanista, or the Drunkard opened, dissected and anatomized*," quarto, London, 1635, p. 45.

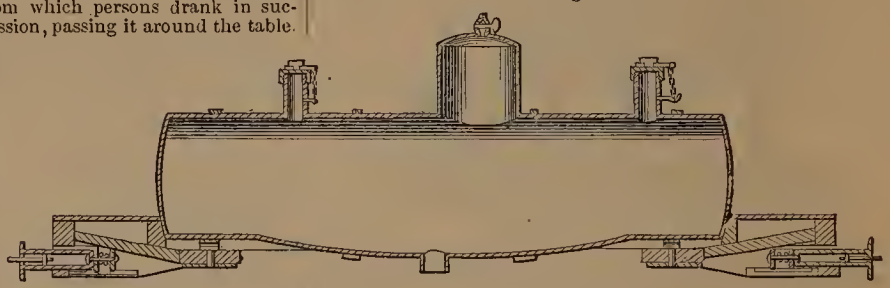
Drinking-pots of wood, with wooden hoops, are yet used in some parts of Britain.

A large drinkiug-glass was found in a Roman-British barrow, in Kent, England; a stained-glass one was excavated from a similar situation. Bede, Luitpraud, and Fordem record them.

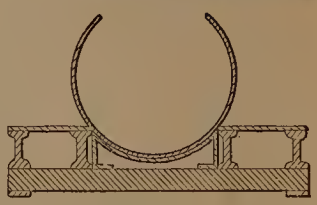
The *grace-cup* was handed round at the end of a meal.

**Tank-car.** (*Railway Engineering.*) A large tank mounted on a platform-truck, for carrying petroleum or other liquid.

Fig. 6197.



They are made in many forms, either of staves or of boiler-iron, usually the latter.



*Oil-Tank Car.*

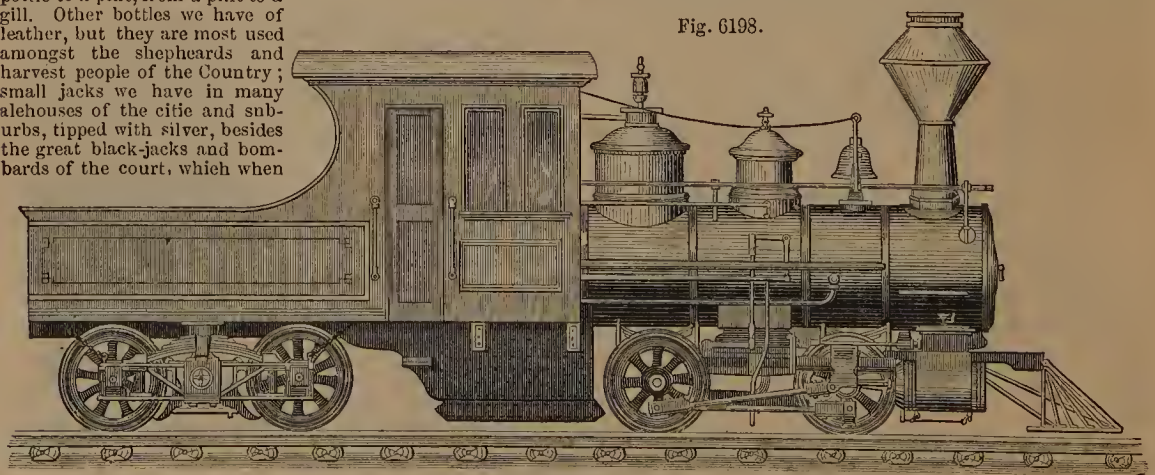
In the example, the cylindrical tube is bellied midway between its ends and on its lowest side. The tank has heads, a filling-gage, a safety-dome, and discharge-passage, which latter is at the convergent point of the bellying or lowest portion of the tank. See also Oil-tank; Tank, 3.

**Tank-en'gine.** (*Railroading.*) A locomotive which carries the fuel and water it requires, thus dispensing with a tender. See Tank-locomotive.

**Tank-lo-co-mo'tive.** (*Railway Engineering.*) One having a tank or tanks enabling it to carry a supply of water sufficient for its own consumption without a tender. Such are used for yard-engines, for side-lines of limited length, and for ascending grades with moderate loads. The boiler and machinery are carried on the driving-wheels, and the variable weight of water and fuel on the tank-truck.

That illustrated is mounted on two bogie frames, the front

Fig. 6198.



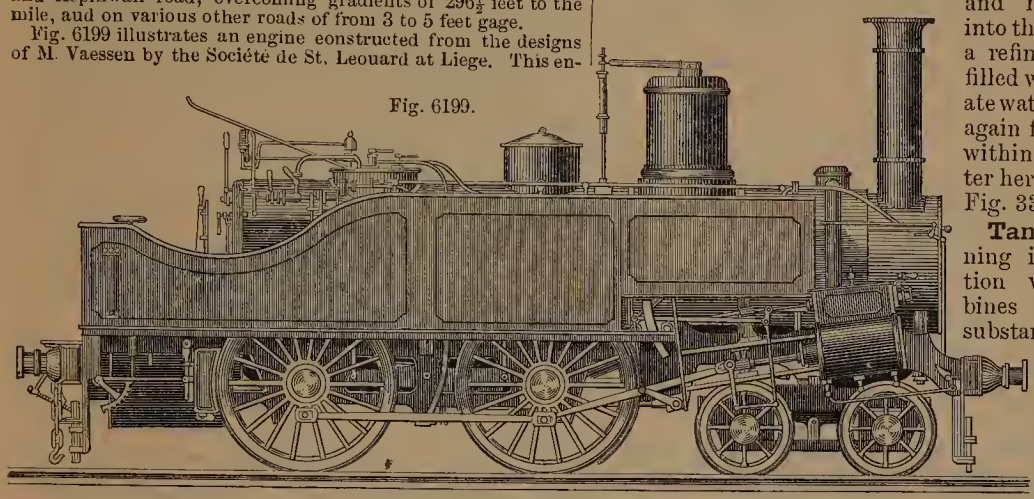
*Tank-Locomotive.*

one supporting the locomotive and the rear one the part in which the tank and coal-bunkers are located.

Engines of this kind have been employed on the Howland and Aspinwall road, overcoming gradients of 296½ feet to the mile, and on various other roads of from 3 to 5 feet gage.

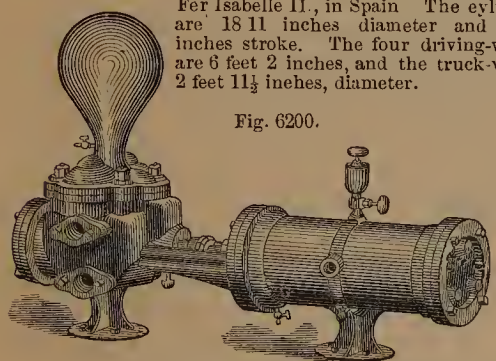
Fig. 6199 illustrates an engine constructed from the designs of M. Vaessen by the Société de St. Leouard at Liege. This engine is intended for the ascent of steep inclines and traversing sharp curves with a train on what M. Vaessen calls the universal system, pateuted by him. It was built for the Chemin de Fer Isabelle II., in Spain The cylinders are 18 11 inches diameter and 24.16 inches stroke. The four driving-wheels are 6 feet 2 inches, and the truck-wheels 2 feet 11½ inches, diameter.

Fig. 6199.



*French Tank-Locomotive.*

Fig. 6200.

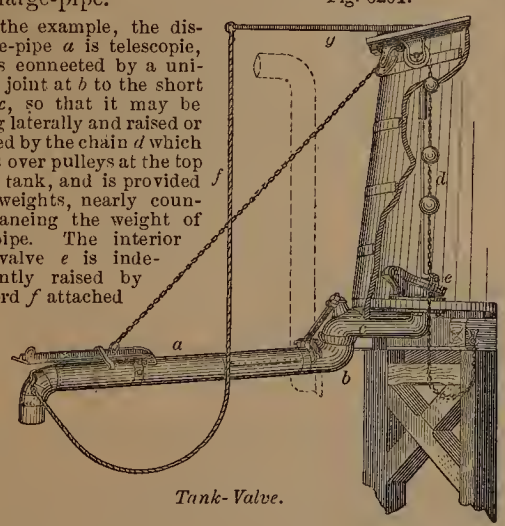


*Direct-Acting Tank Steam-Pump.*

**Tank-pump.** A form of steam-pump for the specific use.

**Tank-valve.** (*Railway Engineering.*) A form of valve used in locomotive water-supply tanks, for admitting water to the discharge-pipe.

Fig. 6201.




*Tank-Valve.*

In the example, the discharge-pipe *a* is telescopic, and is connected by a universal joint at *b* to the short pipe *c*, so that it may be swung laterally and raised or lowered by the chain *d* which passes over pulleys at the top of the tank, and is provided with weights, nearly counterbalancing the weight of the pipe. The interior clack-valve *e* is independently raised by the cord *f* attached to the lever *g*, which has a connecting-rod leading to the valve.

**Tank-ves'sel.** A vessel whose hold forms a cistern for carrying molasses, oil, or other liquid. A brig constructed on this plan discharged her cargo of 88,000 gallons of molasses by means of pumps and hose leading into the reservoir of a refinery, was refilled with Cochituate water, and sailed again from Boston within 27 hours after her arrival. See Fig. 3376.

**Tan'ning.** Tanning is an operation which combines with the substance of the skin any other compound which has the property of rendering it imputrescible and elastic. The agent most generally employed is a soluble vegetable extract termed *tannin*, which forms insoluble compounds with the albumen, gluten, gelatine, and other components of the skin.

Tannin is yielded by the bark of oak, willow, and many other trees (see list, page 2493). The bark of oak is by far the most usual source of tannin. Catechu, valonia, and many other inspissated vegetable extracts are also used.

Another class of agents which fortify the fibrous portions of skins against the joint attack of warmth, air, and moisture are minerals which seem to act as preservative salts on the gelatinofibrous structure of the skin. Such are alum and salt, and copperas. See TAWING.

It is difficult to determine the origin of this art, and it is somewhat confused by translating words referring to hides as if they meant *tanned* hides, that is, *leather*.

Skins and raw hides were first used and were afterward softened by means probably substantially similar to those adopted by the North American Indians. The art was reduced to a scientific basis by Sir H. Davy.

The pounding of skins, and sewing them up and inflating them, or filling them with *tanning* or *tawing* liquor, is shown in the ancient paintings of Kourna, Thebes.

Simeon of Joppa was a tanner, and dwelt by the seaside. Elijah and John Baptist wore leather girdles, perhaps *raw hide*. Strabo refers to the dresses of the Massaytan islanders as being of bark, owing to their having no cattle, and also to the skins used by other people. Pliny's statement of the materials used in treating leather shows that both the *tanning* and *tawing* operations were practiced.

Alum, sulphates of iron and copper, gall-nuts, bark of pomegranate, lotus, wild-vine roots, leaves of sumac, erythron, Rhus coriaria, and many inspissated juices.

The Saracens used alum. Du Cange mentions bark-mills and ground bark.

The art of tanning, though practiced immemorially in Europe, undoubtedly originated in the East, which, until very recent times, had almost a monopoly of the finer kinds of leather. In 1730, a man was sent from France to the Levant to learn the process of morocco manufacture, and in 1749 the first European morocco manufactory was established at St. Hippolyte, in Alsace; the art was not fairly developed in France before 1797.

This manufacture was subsequently introduced into England and Germany. In 1761, McBride of Dublin, and, in 1770, Johnson, introduced the use of dilute sulphuric acid for swelling the hides.

Sumac was used in the first half of the eighteenth century, *divi-divi*, from Caracas in 1768. Catechu at a much later period. Steam-heating vats seem to have originated in America, but formed the subject of a French patent of 1822. The quick process was proposed by McBride in 1759, but he extracted the tanning material with lime-water. It was not until 1793-95 that the active principle requisite to the success of the process — tannic acid — was recognized by Deyeux and Seguin of Paris. It was rendered practical by Fay in England, 1790, and Seguin in France, 1795, and improved by Desmond, Brewin, Cant, and Miller. In 1839 the use of lime from gas-purifying works, previously suggested by Professor Boettger of Frankfort, was introduced into Berlin.

Half-dried sole-leather was formerly rendered compact and, to some extent, flexible, by being beaten by hand with hammers. In Switzerland, as early as 1800, water-power hammers, and, subsequently, stamps were employed. In 1842, Berendorf

of Paris invented pressing-stamps, which were supplemented hy Harvey and Debergue with a roller, which effected the same purpose by its being rolled back and forth over the leather.

Fresh-slaughter hides are washed and scraped on the flesh side; salted hides are sometimes scraped, but dry hides do not require this treatment. Each of the latter kinds is soaked in water 10 or 14 days, and occasionally rubbed or beaten to supple them.

The skins are then placed in pits containing lime-water of 3 or 4 different degrees of strength; they are gradually transferred from the weaker to the stronger solutions, until, in the course of two or three weeks, the lime has dissolved the hair-sheath and, by combining with the fat, formed an insoluble soap. They are *handled*, that is, taken from the pits, and allowed to drain for an hour or two each day. When the hair is readily separable, they are removed from the pit and scraped upon the *beam*, a stand having a rounded upper surface, with the *unhairing-knife* (this is a curved, two-handled scraper, fitting the convexity of the beam); the hair comes off easily, its removal leaving a *grain*. Flesh and fat remaining on the other side are cut off with the *fleshing-knife*, which has a sharp convex edge; this process is termed *fleshing*. The hides are then washed in water, scraped, to get rid of adhering lime, the ears and projecting parts cut off, when they are ready for the tan-pit. The use of lime is objectionable, as it dissolves portions of the skin which would make good leather, makes the surface unequal, and interferes with the action of the tan. Various plans have been tried to avoid its use, among others smoking, causing an incipient fermentation which loosens the hair; piling the hides together and covering them with spent tan or litter, and allowing partial putrefaction to take place; and exposing them to air, kept constantly damp by the spray of water. In some cases weak acids are used, as very dilute sulphuric acid, sour milk, pyroligneous acid, fermented barley, rye-water, and bran; the two latter are sometimes used after liming. The effect of weak acids is to swell the pores, enabling the tanning liquor to penetrate them more readily. This process is termed *raising:* the liquid commonly employed consists of 1 part sulphuric acid to 1,000 parts water. A moderate heat is applied, and the process is completed in 24 hours.

A new English process to open the pores and render the tanning by bark more expeditious, —

1. Remove hair and particles of flesh.
2. Cleanse from the action of lime.
3. Place in a vat, flesh sides up, and cover each hide with bran, in quantity varying from 6 to 14 oz. to each hide, according to size, and cover with water.
4. Ferment. This will take two days or more, according to the weather.
5. Remove and scrape.
6. Steep in a vat, with 5 pounds ground Italian mustard and 5 pounds barley-meal to each 100 weight of hides. Here they remain from 24 to 48 hours, according to size.
7. Hang up to partially dry, and then proceed with the process of tanning by bark.

The tan-yard contains a number of wooden-lined vats, whose tops are level with the surface of the ground. Into these the hides and the ground bark, or ooze previously extracted therefrom, are put. In the old method the alternate layers of hides and of bark were placed in the pits, which were then filled up with water. When the strength of this appeared exhausted, the vat was emptied and supplied with fresh bark and water; this was repeated many times, the process occupying as much as 15 months. It, however, produced superior leather.

It is now customary to prepare the oozes and conduct them to the vats by pipes. The process consists in passing water through a stratum of the ground bark, until all its soluble matters are removed. Usually cold, but sometimes hot or tepid water is employed. Steam is conducted by a pipe beneath a pit containing the tanning material and water, and provided with a perforated false bottom, through which the extract percolates and is drawn off. In another method nearly spent bark is digested in water, at a moderate heat, and the weak ooze is transferred to a pit containing bark which is less spent, and so on until it is finally pumped into a pit filled with fresh bark.

It is common to introduce the skins into nearly spent ooze and transfer them successively to those which are stronger. Those in which the tanning is effected are called *handler-liquor;* stronger oozes, used for giving the *bloom* on the surface, are termed *layer-liquor.*

The skins are usually placed in horizontal layers, but are sometimes suspended vertically. In the process of *handling*, the hides are taken out with blunt-pointed, long-handled hooks, placed one over another, on a sloping rack over an adjacent pit, and permitted to drain for one or two hours.

When ooze instead of bark is employed, the hides are handled frequently.

By one plan, the skins are handled twice a day in the first liquor; once in two days in the second liquor; and once a month in the third liquor.

To save the trouble of handling by hooks in and out of the pit, various devices have been introduced. Several are illustrated under TANNING-APPARATUS.

1. (*Keasley*, 1845.) The hides are suspended from the bars of a frame which is periodically lowered into the liquor and raised therefrom.

2. The hides are temporarily tacked together, so as to form a chain, which is passed down into the vat and then up over a roller, by which they are kept in continuous motion.

3. (*Cagswell.*) The hides are arranged in a vat, laid flatly, except that the edges are a little raised to give the hide a dish form. The hides are packed in sawdust, and the ooze admitted above is allowed to percolate through the hides and sawdust, passing off at the bottom.

4. (*Spilsbury*, 1831.) Each hide is clamped in a rectangular frame, its edges being so nipped as to make it water-tight. Two frames are so clamped together as to make a thin water-tight box into which the ooze is admitted, to percolate through the hides, by hydrostatic pressure.

5. (*Drake.*) The hide is sewed up to form a bag, into which the ooze is admitted from an elevated cistern. The bags may be suspended in a vat of ooze.

6. (*Knowles and Duesbury.*) Hides are placed in a vessel from which the air is withdrawn by an air-pump. The ooze is then admitted under hydrostatic pressure and forced into the pores. The process is repeated with ooze of constantly increasing strength.

7. (*Herapath*, 1837.) Hides are sewed together into an endless band, and are passed between rollers, as they are removed from one pit to another. The object is to press out all of the ooze and open the pores for the reception of the ooze of the next pit.

8. (*Squire.*) Hides are placed in a horizontal cylinder, four fifths full of bides and hot ooze. The cylinder rotates at the rate of 6 or 8 revolutions per minute, and has interior ledges to tumble the hides as it rotates. The ooze is renewed from time to time, but fresh bodies of atmospheric air are excluded.

9. (*Nossiter*, 1844, *English.*) Each hide is contained in a frame which occupies a horizontal position in the pit of ooze. The frames are laid in, one over another, and circulation for the ooze is permitted all around them. The object is to keep them from contact, and the time is said to be shortened one half.

10. (*Berenger and Sterlingue*, *French.*) A series of 8 vats are made to communicate, so that the space between the false bottom and the bottom of No. 1 discharges, by a pipe, into the top of No. 2, No. 2 in the same manner to No. 3, and so on throughout the series, the contents of No. 8 being pumped into No. 1.

No. 1 is first charged with bark and hides and filled up with water. After a period, say from 15 to 21 days, No. 2 is similarly filled, and a quantity of strong ooze is introduced into No. 1, which displaces its former liquid contents and causes them to overflow into No. 2. After a similar interval of time (15 to 21 days), the pit No. 3 is charged with bark and hides, and strong ooze being poured into No. 1, its liquid contents are driven into No. 2, which overflow into No. 3. Again there is an interval, when No. 4 is charged, and so on until No. 8 has been charged and has laid its allotted time under the first liquid. No. 1 is by this time ready to be drawn, and is recharged with fresh bark and hides, the filling of No. 2 with ooze acting throughout the series of pits, the contents of No. 8 being pumped into No. 1, which has now become the last of the series.

11. (*Turnbull*, 1845.) The hides are tanned by endosmotic and exosmotic action, being sewed into the form of bags, filled with weak ooze and suspended in vats of strong ooze. The inequality of density causes a circulation of both liquids through the tissues. The weakness of one and the strength of the other solution must be maintained to preserve energy of action.

12. (*Schynder.*) The hide is indented by means of an instrument having 200 to 300 needles to the square inch. It is then exposed to the action of tan-liquor, which is led by the perforations to the interior portions of the hide.

13. The method employed by the Baskirs and Kirguises of Asia is a *substitute* for tanning, but may be here mentioned. The hair is detached by a knife. The skins are suspended in a pit, from parallel cords. Smoke is introduced into this pit by a tunnel from another pit, in which a fire is made. The fire is a smudge of dry and decayed wood, and both pits are covered in so far as is consistent with a draft sufficient to keep the smoke in effective action.

Two or three weeks are required to put the hides into a tough and lasting condition, impermeable to water.

14. The *Pampas Indians* stretch the hides, so that they shall not shrivel while drying in the sun's rays. The brains are also dried. At the end of the hunting season the hides are steeped, the hair shaved off; the wet hides and powdered brains being placed in an earthen pot and heated to *about* 95°. The villains have no thermometers. The cerebral matter is converted into a kind of soap, and forms a lather which renders the skin pliable.

The skins are then stretched by thongs, and rubbed frequently during the process of exsiccation.

The Esquimaux use in tanning the urine of man and beast. The skins are prepared in the fur, and softened and tanned in urine, which is usually kept in tubs in the porches of their huts for use in dressing deer, seal, and other skins, in the preparation of which they show great skill. The boots worn by the Esquimaux are generally made from seal or walrus hides, and resist water.

A number of distinguished chemists and practical tanners have attempted, and, to some degree, succeeded, in tanning leather by the application of minerals, obviating the use of the vegetable extract, *tannin.*

Of these may he cited the methods of Bordier and Cavalin, and the alum process.

1. *Bordier's Process.* The hides, heing *unhaired* and *bated*, are steeped in a solution prepared as follows: —

224 pounds of hruised copperas are dissolved in 15 gallons of boiling water, in a copper kettle. This heing transferred to a vat of 44 gallons capacity, 44 pounds of sulphuric acid (sp. gr. 1,848) are added, and to this gradually added 44 pounds of hlack oxide of mangauese, in powder, the solution being constantly stirred.

The mixture is thinned with water and the hides steeped therein. The effect is to impregnate them with an insoluhle suh-sulphate of peroxide of iron, and render the animal fiber imputrescible. From 3 to 8 days are required for the process.

2. *Cavalin's process* is to impregnate the cleaned and unhaired hides with a solution of

| | |
|---|---|
| Bichromate of potassa..... | 10 pounds. |
| Alum ..... | 20 pounds. |
| Water..... | 180 pounds. |

They are immersed 4 days, being handled and ruhhed every day.

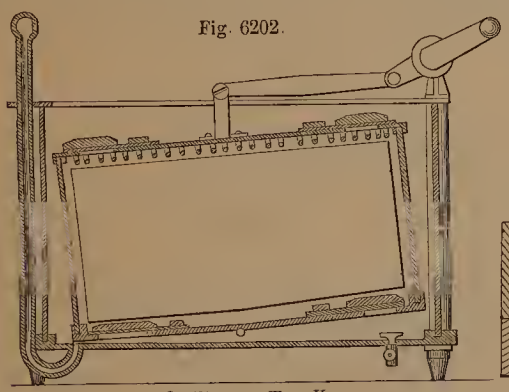
They are next steeped in a solution of

| | |
|---|---|
| Protosulphate of iron..... | 1 pound. |
| Water..... | 1 gallon. |

The hides are not allowed to touch in the vat, hut are takeu out every 12 hours and drained, the process being repeated till the leather is formed.

The iron hase is peroxidized in the hide hy means of the chromic acid, which is itself reduced to the state of sesquioxide,

Fig. 6202.



*Oscillating Tan-Vat.*

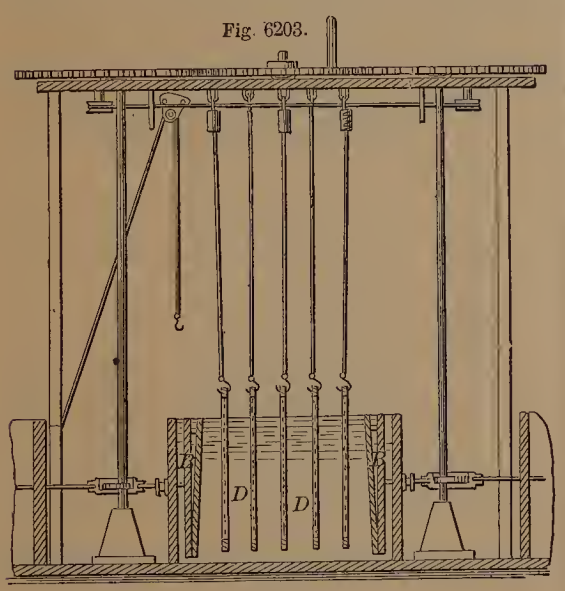
and remains with the iron and a portion of the alumina hase, firmly united with the tissue.

3. The alum process consists in applying to the skins a saturated solution of alum and salt, followed hy dressings of flour, yolk of eggs, oil, etc. See TAWING.

For tanning *in vacuo*, see patents: —

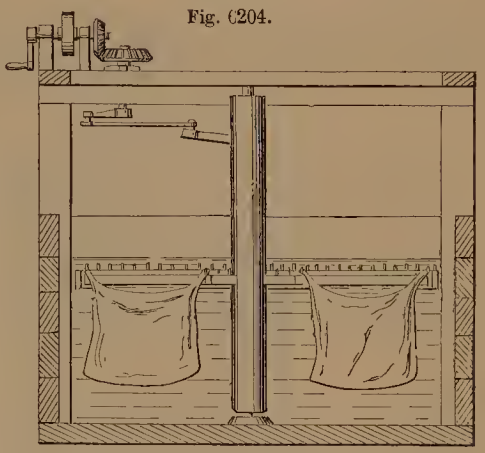
| No. | Name. | Date. | No. | Name. | Date. |
|---|---|---|---|---|---|
| 23,360. | Fergusson. | Mar. 29, '59 | 60,524. | Johnston. | Dec. 18, '66 |
| 29,656. | Aldrich ... | Aug. 21, '60 | 75,391 | Doty ..... | Mar. 10, '68 |
| 48,361. | Brewer *et al.* | Juue 27, '65 | 84,190. | Hosuer... | Nov. 17, '68 |

Fig. 6203.




*Plunging-Vat.*

Fig. 6204.

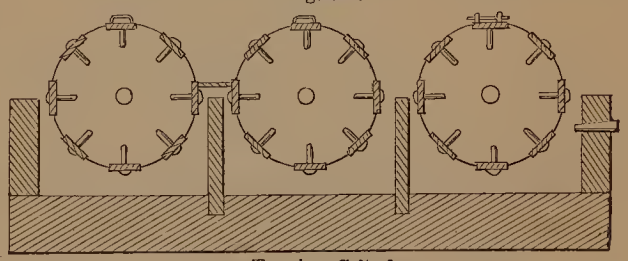


*Rotary-Movement Tan-Vat.*

Symonds' process for utilizing the useful matters which are not withdrawn from the bark by steeping, consists in burning the spent hark and conducting the products of combustion into a trough filled with water, where the solid and soluble portions are retained.

**Tan'ning-ap'pa-ra'tus.** A vat with devices for moving the hides in the liquor, or for circulating the liquid about the hides, in order to expose them to fresh quantities as the liquid in immediate contact with the hide parts with its tannin. Several forms of apparatus have been made, some of which are here illustrated.

Fig. 6205.



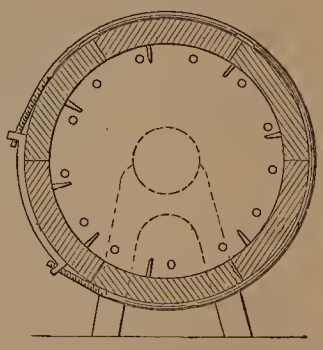
*Tanning-Cylinders.*

1. *Oscillating Movement.* The hides are suspended in a box whose top and bottom are provided with valves opening upward; the hox is oscillated upon a horizoutal axis in a tank of tauning-liquor, and the motion causes a constant upward flow of the liquor, whose gravity is ascertained by an indicator attached.

2. *Vertical Movement.* In Fig. 6203, the hides are distended upon cloths within wired frames *D D*, and, being suspended from a heam, are subjected to the action of rammers *B B* within the vat, hy which they are alternately squeezed and released, causing the circulation of the liquor and the ahsorptiou of tannin by the hides.

3. *Rotary Movement within Vat.* The hides are suspended on the pins upon the rim of a horizontal wheel which has oscillation within the tank hy an arm of its shaft, which is connected by a rod to a crank upon a shaft extending to the outside.

Fig. 6206.



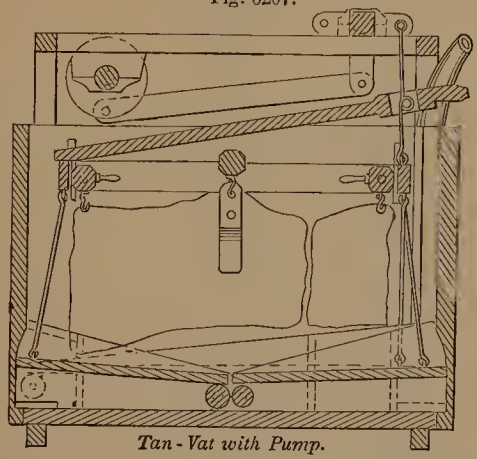
*Revolving-Cylinder for Tanning Hides.*

4. *Rotary Movement of Vat.* The hides are placed in opeu-sided rotatiug cylinders, which are partly suhmerged in vats containing tan-liquor, and have inwardly projecting pins to work the hides.

In Fig. 6206, the barrel is studded inside with pins, and has a perforated false hottom near one end, through which the tanning liquid flows in passing from the tubular induction-gudgeon to the hides within the cyliuder. The liquor passes out through the other gudgeon.

5. *Circulation of Water by Pumps.* Fig. 6207 has a series of lifting-pumps, arranged in and operated at the bottom of the vat, for raising the heavier and strouger liquids from the bottom to the top of the vat, and thus by mixing reuder it of more

Fig. 6207.



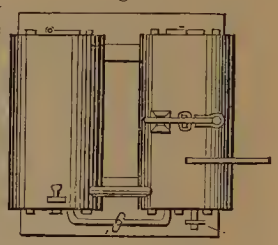
*Tan-Vat with Pump.*

uniform strength throughout. The tanning-liquid is thrown against the hides, suspended in the air, by a force-pump, in a column or in spray.

6. *Vacuum Process.* Air being exhausted from the tank, the liquor is allowed to enter aud penetrate all the interstices between the hides and also the pores of the skins. The exhaust is by means of pumps, or, as in the example, by a pipe with stop-cocks to a separate steam-condenser.

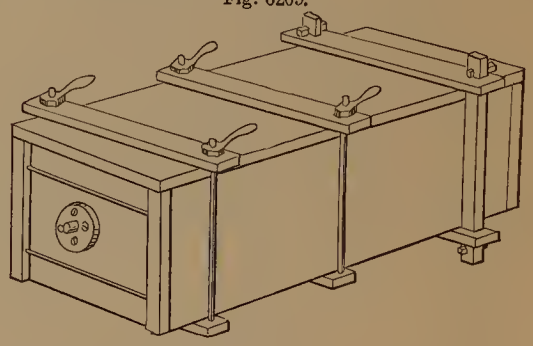
In Fig. 6209, the hides or skins are smoothly stretched or folded in an air-tight vat, and stratified with bark or matting interposed. The air being exhausted and the liquor admitted, the tank can be reversed and adjusted at will by manual power, or at set times by mechanism rotating the vat on its longitudiual axis.

Fig. 6208.



*Tank for Tanning in Vacuo.*

Fig. 6209.



*Vacuum Tan-Vat.*

## TANNING-MATERIALS, DYE-STUFFS, ETC.

| Common Name. | Botanical Name of the Genus or Species of the Plant used or producing the Article. | Native Place, or where chiefly grown. | Qualities, Uses, etc. |
|---|---|---|---|
| Alder bark | Alnus glutinosa | Britain, etc. | The bark produces a yellow or red color. Used in dyeing and tanning. |
| Alkanet root | Anchusa tiuctoria | Shores of the Mediterranean | Used as a dye to stain woods. Its red color is easily imparted to oils, etc. |
| Aloes | Aloe (various) | E. Indies | Afford a brown dye. The leaves of the Socotrine aloe give a violet color that does not require a mordant to fix it. |
| Aniline | A product of coal-tar | Discovered in 1826 by Uuverdorben | From it have been obtained mauve, magenta; also blue, green, violet, and black. See TAR. |
| Argol | Vitis vinifera | Europe, etc. | The coarse cream of tartar produced in casks in which wiue has been stored. Used in dyeing. |
| Arnotto | Bixa orellana | S America | Red colored pulp covering seeds of the plant afford an orange or yellow dye for silks, and to color cheese, butter, and varnishes. |
| Barberry root, etc. | Berberis vulgaris, etc. | Europe, etc | The root, stems, etc., afford a yellow dye The bark is used in tanning. |
| Barwood | (See Camwood ) | | |
| Bedstraw | Galium verum | Europe, etc. | The flower tops afford a yellow dye with alum mordant; the roots a red dye. |
| Beech-bark | Fagus (various) | Europe and N. America | The tannin yielded by this bark makes a white but inferior leather, and is used only in places where oak is scarce. |
| Birch | Betula (various) | Europe and N America | For tanning Russia leather, the inner bark is much used, especially on account of the brown oil which it yields, to which this leather owes its smell and durability |
| Brazil wood | Cæsalpinia brasiliensis | West Indies, Brazil, etc. | The heart-wood affords a red dye. Used also to make red ink. |
| Broom | Cytisus scoparius, or Sarothammus scoparius, and Genista tinctoria | Europe | Used in dyeing yellow. For tanning, and for house brooms. |
| Buckthorn | Rhamnus (numerous) | Europe, etc. | Affords dyeing materials. Sap green from the berry, and yellow from the bark. |
| Campeachy wood | (See Logwood.) | | |
| Camwood | Baphia nitida | W. Africa. | Called also barwood. Affords the red dye used for English bandana handkerchiefs. |
| Catechu | Acacia catechu | E. Indies | A resin-like extract obtained from the bark, wood, and leaves. Used in dyeing and tauning. The leather is very permeable to water, light and spongy, hard, and of a dark reddish-fawn color. The characteristic deposit, from oak hark and a few other tanning agents, known as *bloom*, is not produced by catechu. |
| Chica | Bignonia chica | S. America | Affords a red pigment. Used to give an orange red to cotton goods. |
| Coal-tar colors | | | Aniliue, mauve, magenta, solferino, are all products of coal-tar. |
| Cochineal | Opuntia cochinillifera | Mexico | The cochineal insect (*Coccus cacti*) feeds on this species of cactus, and affords a valuable scarlet and crimson dye. |

| Common Name. | Botanical Name of the Genus or Species of the Plant used or producing the Article. | Native Place, or where chiefly grown. | Qualities, Uses, etc. |
|---|---|---|---|
| Cork-tree | Quercus suber | Spain and Portugal | The *liber*, or inner bark, may be used for tanning. |
| Crottel | Parmelia omphalodes | Europe | A lichen growing on rocks and trees. Used to produce a brown color. |
| Cudbear | Lecanora tartarea, etc. | Sweden, etc | A lichen growing on rocks at high elevations. Used to give a purple color — which is very fugitive — to woolen goods. |
| Cutch | (See Catechu.) | | |
| Divi-divi | Cæsalpinia coriaria | S. America | The fruit-pod of the leguminous shrub is a powerful astringent. Used in tanning. Leather prepared by this substance is very porous, and sometimes tinged brown, unless the air be excluded in the process of tanning. |
| French berries | (See Buckthorn.) | | |
| Fustet | (See Sumac.) | | |
| Fustic | Maclura tinctoria, or Morus tinctoria | W. Indies, Brazil, etc. | Wood affords a yellow dye. |
| Galls | Quercus infectoria | Asia Minor | There are several kinds of galls, or gall-nuts; all produce gallic acid. Used in dyeing black, ink-making, tauuing, and as a styptic. The gall is an excrescence produced on the species of oak named by the puncture of the insect, *Cynips quercusfolii*. |
| Gambir, or Terra japonica | Uncaria gambir | E. Indies, Malay Islands, etc. | Used in dyeing and tanning. Coutains a principle called *catechine*. It was formerly called *terra japonica*, as it was supposed to be an earth from Japan. It is the inspissated juice of a slender-stemmed, vine-like shrub with oval leaves and clusters of pale purplish flowers. The leaves and branches are boiled to obtain the astringent extract, which is condensed by evaporation and dried in little squares. It is used by the Malays as a dye, a salve, and a masticatory with betel-nut and tobacco. |
| Garancine | Rubia tinctoria | S. Europe, etc. | The dye-principle of madder; obtained from it by the action of sulphuric acid. |
| Gum-trees | Eucalyptus (various) | Australia | Contain an astringent principle which can be used in tanning. |
| Heather | Calluna vulgaris | Europe | Affords a yellow dye. |
| Heaths | Erica (various) | Europe | Some kinds used in tanning. |
| Hemlock bark | Abies canadensis | N. America | In union with oak-bark, is supposed to produce the best leather. Hemlock alone produces leather inferior to that prepared with oak-bark, and, besides, imparts to it a red color. In America, it is largely used as a substitute for the bark of the oak. |
| Henna | Lawsonia inermis | Africa, Arabia, etc. | The powdered leaves used to dye leather, etc., a reddish yellow or orange. In Egypt, it is employed by the women to give an orange color to the nails. |
| Indigo | Indigofera anil, tinctoria, etc. | India | A very valuable blue dye. |
| Kelp | Fucus vesiculosus, etc. | Sea-shores | The ash of various kinds of sea-weed. Affords soda, etc. |
| Kermes | Quercus coccifera | S. Europe | The kermes (*Coccus ilicis*) feeds on the leaves of a species of oak, and affords a red dye. Its use is of very ancient date. |
| Kino | Pterocarpus marsupium, Pterocarpus erinaceus | E. Indies, Africa | Used as a yellow dye for cotton in the East Indies. |
| Lac-dyes | Ficus religiosa, etc. | E. Indies | The *Coccus lacca*, by puncturing trees of the East Indies, produces shell and other lacs, that afford beautiful red dyes. |
| Larch | Larix alba | Europe, etc. | For tanning, inferior to oak. |
| Lichen dyes | Lecanora rocella, etc | Cool climates | Many genera and species give dyes; as cudbear, litmus, orchil, etc. |
| Litmus | Rocella tinctoria | Canaries, S. Europe, etc. | A lichen used to give a purple dye to silks. Used in chemistry as a test for alkalies and acids. |
| Logwood | Hæmatoxylon campechianum | Central America. | Used in dyeing red and black colors, shades of purple, etc. Called also campeachy wood. |
| Lombardy poplar | Populus dilatata | | For tanning. Imparts a fragrant smell to the leather, similar to that of Russia leather. |
| Madder | Rubia tinctoria, etc | France | Employed to produce the celebrated Turkey red and other dyes. Affords garancine by the action of sulphuric acid. |
| Madder (Indian) | (See Munjeet.) | | |
| Mangrove bark | Rhizophora mangle | Tropics | The bark is very astringent. Used for tanning. |
| Mimosa | Mimosa | Warm climates | The bark of an Australian species may be used in tanning. |
| Munjeet | Rubia cordifolia | N. India | Used for the same purposes as the European madder. Also affords garancine. |
| Myrobalans | Terminalia (various). | India | The fruit husk possesses an astringent principle. Used by tanners. |
| Nicaragua wood | (See Peach-wood.) | | |
| Nutgalls | (See Galls.) | | |
| Oak bark | Quercus (various). | Europe, etc. | The bark is employed in tanning and dyeing. It is stripped in spring; dried, ground, and steeped to extract the tannin. |
| Orchil, or Archil | (See Litmus.) | Europe | Is properly litmus in an early state of preparation, when it possesses a purple color. |
| Peach-wood, or Nicaragua wood | Cæsalpinia brasiliensis | S. America | Used as a material for red dyes. |
| Pearlash, or Potash | Various plants | Russia, America. | Procured by burning many woods and plants, and lixiviating the mass. Used for scouring wool and for cleansing generally; also in soap. |

| Common Name. | Botanical Name of the Genus or Species of the Plant used or producing the Article. | Native Place, or where chiefly grown | Qualities, Uses, etc. |
|---|---|---|---|
| Persian berries | (See Buckthorn.) | | Afford a yellow dye. |
| Pomegranate bark | Punica granatum | Europe, etc. | Used in dyeing. Especially to give morocco leather a yellow dye. |
| Quercitron | Quercus tinctoria | N. America | A valuable yellow dye is obtained from the bark of the tree. |
| Safflower | Carthamus tinctorius | India, China, S. Europe, etc. | The flowers afford a yellow and red dye. Used in dyeing silks various shades of rose-pink, and in making carmine-rouge. |
| Saffron | Crocus sativus | S. Europe, etc | Used as a yellow coloring material. Obtained from the stigmas or tops of the flowers. |
| Sanders-wood (red). Santal-wood. Saunders-wood. | Pterocarpus santalinus | India | The wood affords a reddish-brown color, as a dye for woolen goods, also red and scarlet with certain mordants. |
| Sap-green | (See Buckthorn.) | | |
| Sappan-wood | Cæsalpinia sappan | India and Ceylon | A wood much used as a red dye-stuff. |
| Spanish berries | (See Buckthorn.) | | |
| Sumac, or Sumach | Rhus cortinus. Rhus coriaria. | S. Europe | The powdered leaves and young branches are used in tanning and dyeing orange, yellow, and black. |
| Tannin | | | A principle obtained from galls, oak-bark, etc. Used in tanning. It has the power of solidifying the gelatine of animal substances, as skins, and thus converting them into leather. |
| Terra japonica | Uncaria gambii | Malay Islands | Also called gambir. Used largely in tanning and dyeing. |
| Turkey berries | (See Buckthorn.) | | |
| Turmeric | Curcuma longa | India, etc. | The powdered root (also called Indian saffron) affords a yellow dye. Is used in chemistry as a test for free alkalies. |
| Valonia | Quercus ægilops | Greece, Asia Minor | The acorns and cups of this species of oak are used in dyeing and tanning. Leather prepared by this substance is harder and less permeable to water than that made with oak-bark. |
| Weld | Reseda luteola | Britain, etc. | The leaf and stems yield a yellow dye. |
| Willow bark | Salix alba | Europe, etc. | Remarkable for its astringent taste. Leathers made from kid and lamb skins owe their agreeable smell to this bark, with which they are tanned. |
| Woad | Isatis tinctoria | Britain | Used to dye blue colors. Now superseded by indigo. |
| Wongshy | Gentiana (?) | Batavia | Yellow dye-stuff obtained from the seed-vessels of the plant. |
| Yellow berries | (See Buckthorn.) | | |

**Tan-nom'e-ter.** A hydrometer for determining the proportion of tannin in tanning liquor.

**Tan-pit.** A sunken vat, in which skins are steeping in tanning liquor.

**Tan'ty.** (*Weaving.*) The Hindoo loom, consisting of bamboo beams for the warp and cloth, a pair of heddles moved by loops, in which the big toes are inserted, a needle which answers as a shuttle, and a lay.

**Tan-vat.** A pit or tank in which tanning of hides is accomplished. See TANNING-APPARATUS.

**Tap.** 1. (*Machinery.*) A tapering, longitudinally grooved screw of hardened steel, having a square head, so that it may be turned by a wrench. It is used for cutting an internal screw, as that of a nut. See SCREW-TAP, Fig. 4754.

The most primitive kind of tap (Fig. 6210, *a*) is formed by filing four planes upon the screw: this gives very obtuse cutting edges. In *b*, three planes only are filed away, giving an angle more favorable for cutting. These sections are used for very small taps. The half-round tap *c* gives the most favorable cutting angle, and has been recommended as cutting a clean thread with comparatively small labor; the form *d* has also been employed. Taps with three or five cutting edges *e f* are more common; it is usual to form them with elliptical grooves, which permit the shavings to escape readily, and are easily wiped out.

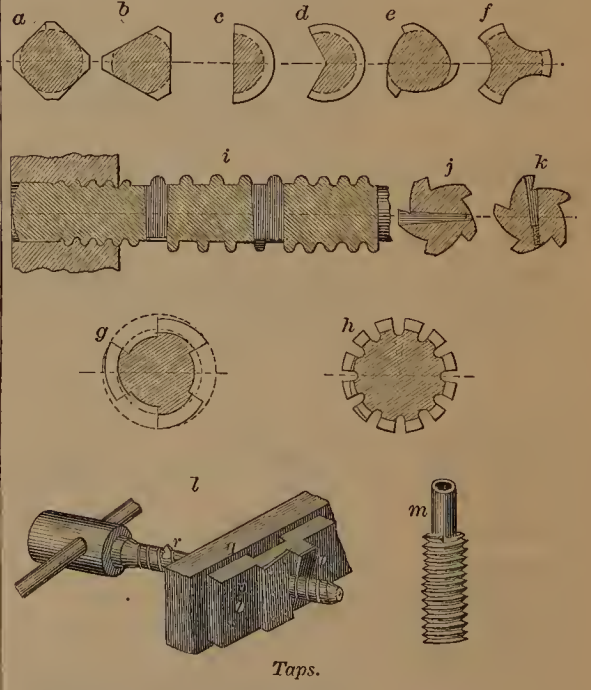
In Bodmer's tap *g*, the cutting edges of the teeth are made prominent, their faces inclining backward at an angle of 3° from a true circular curve, so as to reduce the friction of the tool.

For cutting screw-dies and tools and other thin articles, the tap *h* has a larger number of grooves, and a greater proportion of its face is left standing to give it a sufficient bearing on the metal.

Taps with removable cutters have been used. *i j k* is Jones's tap. Tapering holes are made in the body of the tap to receive the cutters, which are caused to project slightly beyond the general surface by a slip of paper placed within the mortise. Sometimes they are made parallel and protruded by a set-screw. *l* shows a wood screw-cutting tap of this kind. It has a square helical groove, which fits two plates on the guide *p* through which the tap passes, and which is secured to the wood *q* to be tapped; the cutter *r* is inserted in a radial mortise.

*m* is a hollow tap for the same purpose; a hole is made at the termination of the thread, and chamfered so as to form a cutting edge, the shavings passing into the central hollow of the tap.

Fig. 6210.

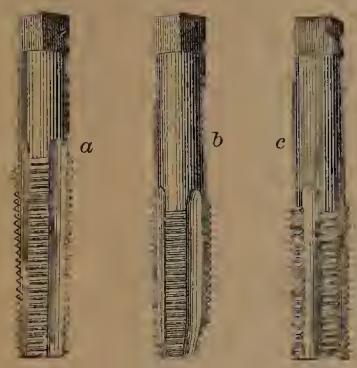



*Taps.*

Master taps are used for cutting the dies employed in cutting screw-threads. In some cases, for deep threads, two pairs of dies are employed, but generally one pair is cut by a tap one depth larger than the screw.

The process of screw-cutting was greatly improved by Maudslay, who introduced the practice of having three cutting edges, and using three taps, the entering taper tap, the middle tap, and the plug tap, by which shallow or *dead* holes in cast-iron can be safely tapped with full threads.

Fig. 6211.

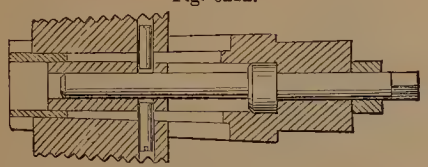



*Taps.*

*a*, taper-tap.
*b*, plug-tap.
*c*, bottoming-tap.

Fig. 6212 is an expanding-tap, the cutter being inserted in inclined dovetailed grooves in the sides of the stock. They are connected by screws to a plug sliding in a hole bored in the axis of the stock, and which serves to draw them up or down on the inclines to increase or decrease the diameter.

Fig. 6212.



*Expanding-Tap.*

2. A faucet.

3. The heel of a boot, made up of *lifts*.

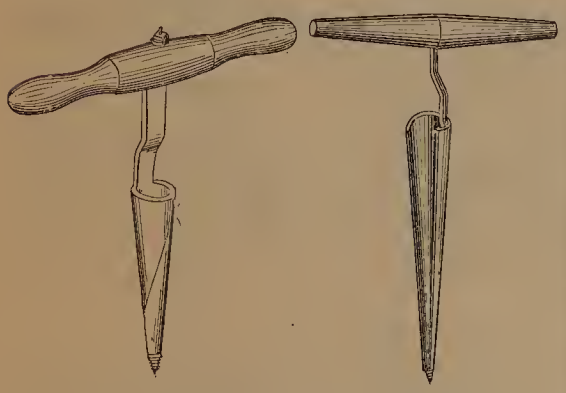
**Tap-bor'er.** A tapering boring-instrument for making spigot or bung holes in casks.

Fig. 6213 has a sharpened, salient, spiral edge, and a gimlet-point.

Fig. 6214 is the half of a hollow cone, with a sharpened edge and gimlet-point

Fig. 6215 has a ring shank for a handle.

Fig. 6213. Fig. 6214.



*Tap-Borer.* *Tap-Borer.*

**Tape.** 1. (*Fabric.*) A narrow linen or cotton fabric, twilled or plain, white or colored.

2. (*Printing.*) *a.* One of the traveling-bands which hold and conduct the sheet of paper in a

Fig. 6215.

*Ring Tap-Borer.*

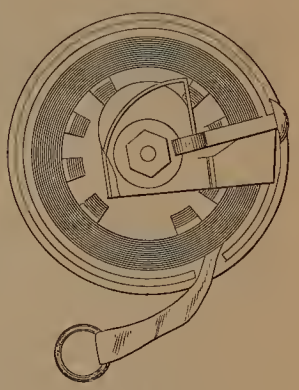
power-press. The *nippers* take the sheet from the feed-board, and the *fly*, taking it from the tapes, delivers it on to the heap.

*b.* A similar band in a paper-folding machine.

**Tape-car'ri-er.** A tool-holder, like a frame-saw, in which a corundum tape is mounted to be used in cutting or filing.

**Tape-fuse.** A long, flexible, ribbon-shaped fuse, containing a composition which burns with great rapidity. By means of a fuse of this kind, a charge of powder may be exploded at the distance of several hundred yards, and apparently almost simultaneously with the communication of fire to the other end.

Fig. 6216.



*Tape-Measure.*

**Tape-line.** A measuring-tape winding into a case.

**Tape-meas'ure.** A ribbon of tape or other material winding upon an axis inside a case.

They are made of *linen* or *steel*, from 10 to 100 feet long, and divided into feet, inches, and subdivisions of an inch.

The linen tape-measures of the best quality are interwoven with fine brass wire, to prevent stretching.

The example is so arranged that pressure on the plug will hold the tape at any desired point.

**Tape-pri'mer.** A narrow strip of flexible material, usually paper, containing small charges of fulminating composition at short and equal intervals apart, and covered with a water-proof composition, as the Maynard primer. It was never much favored in the service, and has been superseded by the plan of placing the fulminate within the cartridge.

The tape-primer required a peculiar lock, having a recess for containing the tape and mechanism for advancing each primer successively to the nipple.

**Ta'per.** A small wax-candle. Usually having a long wick with such a covering of wax as to allow the taper to be coiled.

Wax tapers are made by drawing a string through a pan of melted wax at a speed regulated according to the thickness desired.

**Ta'per-file.** A file which is rectangular in section, and whose thickness and width gradually decrease toward the *point*.

The faces are not quite flat in the direction of their length, but are somewhat rounded; technically known as *bellied*.

A flat file, without a belly, is known as a *parallel* file.

**Ta'per-vise.** One whose cheeks are arranged to grasp objects whose sides are not parallel. See VISE.

**Tap'es-try.** (*Fabric.*) A kind of woven hangings of wool or silk, frequently raised and enriched with gold and silver, representing figures of men, animals, historical subjects, etc. The term is of somewhat indefinite meaning, and the purpose equally indeterminate. It was originally intended for hangings, to hide the wall, or make a screen or curtain. Ovid mentions human figures as worked on the curtains of theaters.

For an account of ancient tapestry, see Smith's "Dictionary of Greek and Roman Antiquities," article "Tapes."

Tapestry is described in the Book of Exodus

"Plato, the comic poet, namesake of the philosopher, says: —

'There the well-dressed guests recline
On couches rich with ivory feet;
And on their purple cushions dine,
Which rich Sardinian carpets meet.'

For the art of weaving embroidered cloths was in great perfection in his time; Acesas and Helicon, natives of Cyprus, being exceedingly eminent for their skill in it, being weavers of very high reputation." — ATHENÆUS (A. D. 220).

The tapestry of Pollux, τάπητες, was woven shaggy; the *amphitapetia* was shaggy on both sides; the *tapetia* only on one side; the *ephestris* was shorn.

Tapestry-hangings are said to have been invented by the Pergamenians. Attalus III. bequeathed his kingdom to the Romans, and thence, it is said, hangings were introduced into Italy. The Greeks and Latins had embroidered hangings. These hid the bad carpentry or stone walls. The Anglo-Saxons had wall-hangings of silk, embroidered with needlework or plain. Tapestry was common in England to the time of Elizabeth.

Tapestry was made in France at a very early date. The oldest and most celebrated specimen in existence is the Bayeux tapestry, containing embroideries representing the conquest of England by William the Conqueror, and supposed to have been worked under the supervision of his queen, Matilda. Tapestry was first made by the loom in Flanders. The manufactory at Fontainebleau was established by Francis I. in the sixteenth century; that at Gobelin's was enlarged under Louis XIV.

The French ascribe the invention to the Saracens, and formerly called the workmen who were employed in its manufacture *sarazins*.

The manufacture was introduced into England by Sheldon, in the reign of Henry VIII. It was encouraged by his successors. Hampton Court Palace yet displays their tapestry on its walls.

These hangings were a very ornamental accession to the bare walls of the buildings of some centuries since. Arras, Brussels, Antwerp, and Valenciennes excelled in the manufacture, but the best known at the present day is the factory at the Gobelin's, near Paris. It is named after Giles Gobelin, a French dyer, of the reign of Francis I., and was established by Henry IV. about 1606, and much enlarged by the renowned Colbert in 1666. It is said to have been conducted by Flemish artists.

*Hand* tapestry is embroidered by the needle, woolen or silken threads being worked into the meshes of a fabric.

*Basse lisse* is woven upon a loom. The warp is horizontal, and is stretched above the pattern to be copied. The weft is inserted by a *flute*, which partakes of the characters of a needle and a shuttle. A treadle arrangement depresses some of the threads and forms a parted shed. The face of the work, being downward, cannot be inspected until it is removed from the loom; this inconvenience, probably, led to the substitution of the *haut lisse*, in which a vertical warp is stretched between a warp beam and a cloth beam. The pattern is placed at the back of the warp, through the threads of which it may be seen, and the outlines are copied upon the warp. The weft and pattern are then worked in with needles corresponding in number to the kinds and colors of threads used.

**Tap'es-try Car'pet.** 1. A two-ply carpet in which the warp is first printed and then woven.

2. The patent tapestry rugs have a velvet pile surface with a thick weft shoot of cotton, flax, or other material.

3. Tapestry Brussels carpet, called *moquette*, of a fine quality. *Wilton* carpet.

4. Mosaic tapestry; the cut wool is fixed to the ground by caoutchouc.

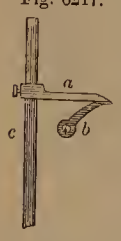
The Persian and Turkish modes of using carpet are the most ancient, the sizes being comparatively small, and placed about a room rather for individual convenience than as a general covering. The terms *tapestry* and *carpet*, or the originals thus translated, are in a little confusion. The ideas are now distinct, but when both were made by hand and in smaller pieces, the differences were rather of position than character. The rugs covered the *triclinia*, or were laid upon the floor, as appears in the representations in Pompeii, and later in the altar-cloths of the choirs in cathedrals and abbeys.

It is recorded that Sinchius, Bishop of Toledo, in 1255, covered his floor with tapestry,—an example followed by Eleanor of Castile, wife of Edward I.

Bedside carpets occur in 1301 on the Continent of Europe; and in the fifteenth century a carpet is shown around a throne, and a bedside rug with a handsome pattern, the remainder of the floor having a checkered matting of two colors.

**Tap-hole.** An opening at the base of a smelting-furnace for drawing off the molten metal. It is stopped by a plug of refractory clay (*bot*), which is removed in the act of tapping.

Fig. 6217.




*Tappet.*

**Tap'lings.** The whang-leather straps which connect the *souple* and *hand-staff*.

**Tap'net.** A rush basket in which figs are imported.

**Tap'pet.** (*Machinery.*) *a*. A projecting arm *a* which is touched by a cam *b*, or other moving object, in order to impart an intermittent reciprocation to the rod *c*. Specially used as a valve-motion in steam-engines.

*b*. A similar device on the stem of a stamp in an ore-battery. It is struck by a cam, lifting the stamp, which falls as the cam slides from under the tappet, its shoe striking the ore in the mortar.

**Tap'pet-mo'tion.** (*Steam Engineering.*) The apparatus for working the valves of some forms of condensing-engines. The valve-rods have levers attached, which are moved by projecting *tappets* on a rod connected to the beam.

**Tap'pet-wheel.** (*Machinery.*) A wheel having spurs on its periphery, adapted to trip a lever, trip-hammer, fulling-mallet, etc., or to raise the stamps of an ore-mill.

**Tap'ping.** 1. Screw threading a hole.

2. (*Founding.*) The jarring of a pattern in its bed in the sand to give it *clearance*. With small castings this is done by sticking a skewer into the pattern and *tapping* it with the *slicker* or *trowel*; with larger castings more energetic means are employed, but in the same way.

3. Boring a hole in a pipe, cask, etc., to insert a plug, connect a branch-pipe, or introduce a faucet, as the case may be.

4. Boring maples for *sugar-water*, as it is called in the Western, or *sap*, in the Eastern States.

**Tap'ping-ap'pa-ra'tus.** 1. For threading screws. See SCREW-TAP; TAP; TAPPING-MACHINE, 1.

2. For opening the flow-hole of a furnace. See TAPPING-BAR.

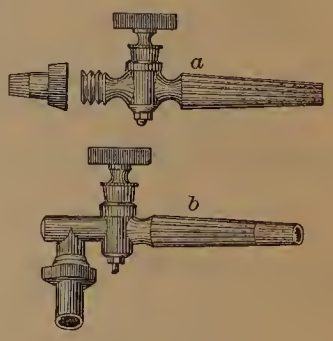
3. For cutting the bark and alburnum of the maple. See TAPPING-GOUGE; AUGER.

4. For boring holes in mains or pipes. See TAPPING-MACHINE, 2; TAPPING-DRILL.

5. For inserting a faucet in a cask. See TAPBORER; TAP-COCK.

**Tap'ping-bar.** (*Founding.*) A round bar with a sharp point, used for letting out the metal from the furnace into the ladles. Two such are generally used; the first a light bar with a chisel edge to clean away the unburned clay from the tap-hole.

Fig. 6218.



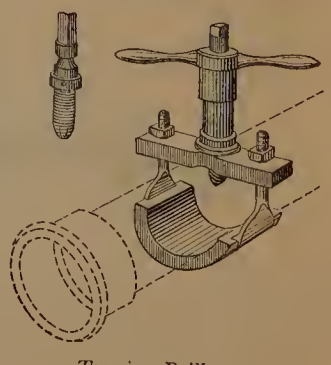

*Tapping-Cocks.*

*a*, straight-nose tapping-cock.
*b*, bent-nose tapping-cock.

**Tap'ping-cock.** A cock having a taper stem, enabling it to be fixed firmly in an opening by driving.

**Tap'ping-drill.** One for boring holes in water mains and pipes. A strap goes below the pipe, and has screw-bolts which hold the cross-piece, and also the tube in which the drill-stem works.

Fig. 6219.



*Tapping-Drill.*

**Tap'ping-gouge.** A gouge used in tapping the sugar-maple, and in making the spiles to conduct the sap to the buckets.

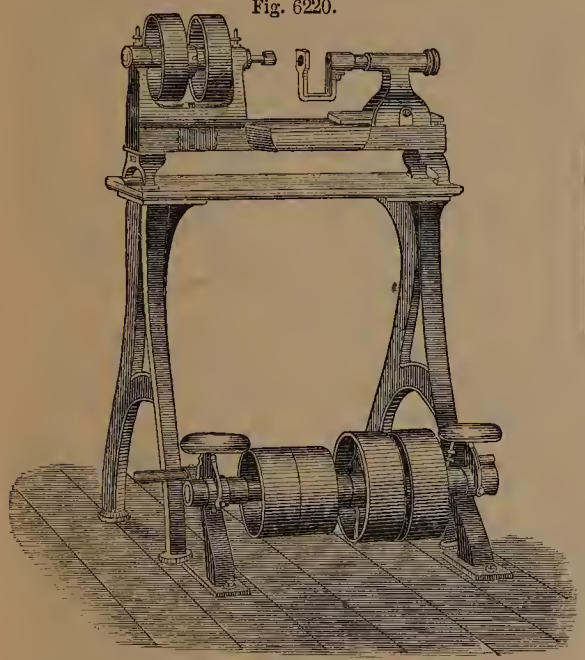
In the West the liquid is called *sugar-water*; in the East, *sap*.

Tapping with the gouge is not now so common; boring with the auger and inserting an elder or a turned spile is the usual plan.

**Tap'ping-ma-chine'.** 1. (*Metal-working.*) A machine for tapping out internal screw-threads.

In that illustrated, the taps are held in a chuck fixed in the rotary mandrel of the stationary head, and may project as far as desired. The work is held in a clamp on the sliding-head, which is advanced toward the tap. An arrangement is provided for gaging the penetration of the tap when the hole is not to pass through the work, and the motion is reversed in the act of drawing back the work.

Fig. 6220.

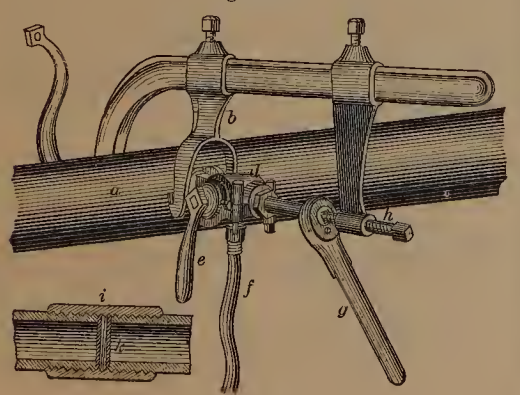


*Brown and Sharpe Tapping-Machine.*

2. A machine for tapping water-mains.

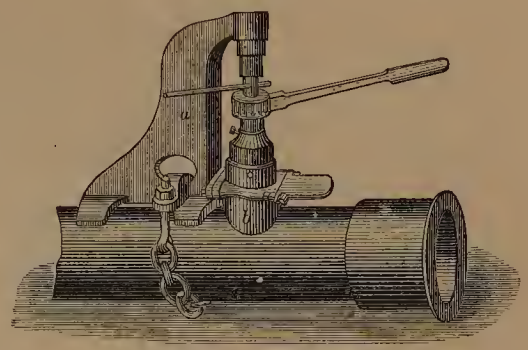
*a* is the main, against which the device is held by the movable arm *b*. The drill passes through the two-part drill-holder *d*. At the end nearest the pipe is a detachable washer in a socket, having a concave face, which is clamped against a packing-gasket to make a water-tight joint. The handle *e* operates a cock within, through which the drill passes, and which closes the opening when the drill is removed. The connecting-pipe is then substituted for the drill, the cock opened, and the connection made. The hose *f* conducts away the chips. The drill is operated by the ratchet-lever *g* and fed by the screw *h*. *i* is an arrangement for dispensing with the cock usually employed in making connections, and which is afterward left in the earth. A glass plate *k* is interposed between the ends of two sections of pipe, and crushed by screwing the sections together. The pieces are washed out by the flow of water.

Fig. 6221.




*Tapping-Machine.*

Fig. 6222.



*Gas-Main Tapping-Machine.*

The apparatus (Fig. 6222) is for tapping gas-mains without causing escape of gas. The curved standard *a* is lashed to the pipe, the drill-stock works through a hollow foot *b*, which is cushioned to render it gas-tight, and is provided with a sliding-valve arrangement, which is closed when the drill is lifted, and kept so until the end of the service-pipe is to be inserted.

Machines for tapping gas and water pipes and mains. Patents: —

| | | |
|---|---|---|
| Nos. 24,949 | 65,863 | 129,853 |
| 25,216 | 77,453 | 129,869 |
| 30,051 | 112,626 | 130.577 |
| 30 901 | 113,314 | 133.016 |
| 45,964 | 119,895 | 136,621 |
| 46,246 | 122,668 | 144,374 |

**Tap'ping-tool.** A tool for tapping maple-trees to obtain the resulting sap (New England), or sugar-water (the West), which exudes from the alburnum principally. Tapping is done by a gouge and mallet, by an axe, or by an auger.

**Tap-plate.** A steel plate furnished with a number of holes which are wormed and notched, to adapt it for cutting threads on blanks.

Fig. 6223.

*Tap-Plate.*

**Tap-wrench.** A two-handled lever for rotating a tap used in forming an interior screw-thread. The shank of the tap is held between a fixed and a movable die, which are approached by a screw, and are adapted to hold shanks of various sizes. See DIE-STOCK.

Fig. 6224.

*Tap-Wrench.*

**Tar.** A dark-colored resinous substance obtained by distillation from the pine or from coal.

There are many oils resulting from the distillation of coal-tar; some of the light ones being used to produce local insensibility to pain, such as the freezing of the gum in dental operations. One of these light oils, benzol, exhibits in a remarkable degree the number and value of the coal-tar productions. Fifty years ago, in 1825, Faraday discovered, while experimenting on coal-tar, the substance now known as benzol. Twenty years after, a French chemist found that when benzol was treated with nitric acid, a substance called nitro-benzol resulted, having the odor of bitter almonds, and now used for giving almond soap its odor.

About the same time a Dutch chemist discovered a beautiful blue color while experimenting on indigo, and shortly after a blue solution was obtained in alcohol from nitro-benzol. It was soon proved that the two blue colors were of exactly the same constitution, and they were called aniline. They were regarded as curiosities, but no practical use was made of them, as there were many kinds of blue dyes, and much cheaper than aniline. But in 1856 an English chemist, Perkins, while searching for a cheap method of preparing quinine, from nitro-benzol, obtained a beautiful solution of *mauve* color. This was found to be such an effective dye that numerous experiments were made on this substance, and the result is considerably over three hundred dyes of all the beautiful colors of the spectrum, red, orange,

yellow, green, blue, indigo, and violet; first came the *mauvine* and *rose aniline* in 1856, then the *aniline red* in 1859, then the *aniline blue* in 1860, then the *aniline green* in 1863; after that the violets of methylic and ethylic *rosaline*, and *aniline black*.

In 1870, *alizarine*, the coloring principle of madder, was produced from one of the coal-tar products.

Dr. Hofmann, of the University of Berlin, furnishes, in "Percy's Metallurgy," the following list of the compounds generated by the destructive distillation of coal, the new atomic weights being used.

| | |
|---|---|
| Hydrogen | $H$ |
| Water | $H_2O$ |
| Carbonic oxide | $CO$ |
| Carbonic acid | $CO_2$ |
| Sulphurous acid | $SO_2$ |
| Hydrosulphuric acid (sulphuretted hydrogen) | $H_2S$ |
| Bisulphide of carbon | $CS_2$ |
| Hydrocyanic acid | $HCN$ |
| Hydrosulphocyanic acid | $HCNS$ |
| Acetic acid | $C_2H_4O_2$ |
| Carbolic acid (phenol) | $C_6H_6O$ |
| Cresylic acid (cresol) | $C_7H_8O$ |
| Phlorylic acid (phlorol) | $C_8H_{10}O$ |
| Rosolic acid | $C_{20}H_{10}O_3$(?) |
| *Hydrocarbons.* | |
| Methane (marsh gas) | $CH_4$ |
| Sextane (propyl) | $C_6H_{14}$ |
| Octane (butyl) | $C_8H_{18}$ |
| Decane (amyl) | $C_{10}H_{32}$ |
| Duodecane (caproyl) | $C_{12}H_{26}$ |
| Paraffine | $C_{10}H_{2n+2}$(?) |
| Ethene (olefiant gas) | $C_2H_4$ |
| Tertene (propylene) | $C_3H_6$ |
| Sextene (caproylene) | $C_6H_{12}$ |
| Septene (ænanthylene) | $C_7H_{14}$ |
| Ethine (acetylene) | $C_2H_2$ |
| Benzol | $C_6H_6$ |
| Toluol | $C_7H_8$ |
| Xylol | $C_8H_{10}$ |
| Cumol | $C_9H_{12}$ |
| Cymol | $C_{10}H_{14}$ |
| Naphthaline | $C_{10}H_8$ |
| Anthracene | $C_{14}H_{10}$ |
| Phenanthrene | $C_{14}H_{10}$ |
| Fluorene | $C_{13}H_1$ |
| Pyrene | $C_{16}H_{10}$ |
| Crysene | $C_{18}H_{12}$ |
| *Basic Nitrogen Compounds.* | |
| Ammonia | $H_3N$ |
| Aniline | $C_3H_7N$ |
| Pyrodine | $C_5H_7N$ |
| Picoline | $C_6H_7N$ |
| Lutidine | $C_7H_9N$ |
| Collidine | $C_8H_{11}N$ |
| Parvoline | $C_9H_{13}N$ |
| Corindine | $C_{10}H_{15}N$ |
| Rubidine | $C_{11}H_{17}N$ |
| Viridine | $C_{12}H_9N$ |
| Chinoline, Leucoline | $C_9H_7N$ |
| Lepidine | $C_{10}H_9N$ |
| Cryptidine | $C_{11}H_{11}N$ |
| Pyrrol | $C_4H_5N$ |

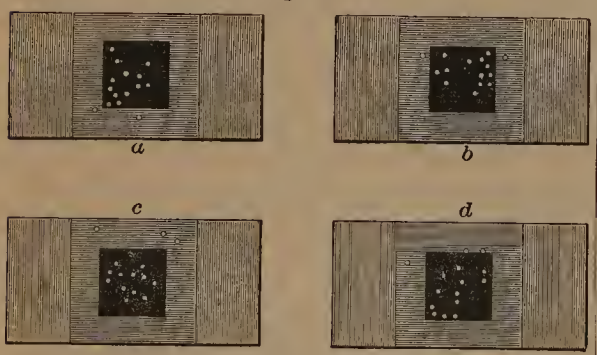
Tarring and feathering was a punishment of offeuding Crusaders (Hovedon, "Temp. Richard I."). A bishop of Hulverstadt stripped, oiled, pitched, and feathered a number of monks and nuns.

**Tar-board.** (*Paper.*) A strong quality of millboard made from junk and old tarred rope.

**Tar'get.** 1. A butt or mark in archery or rifle-shooting.

Fig. 6225 illustrates shots made by three of the contestants at the recent shooting-match at Creedmoor betweeu the American and Irish teams; each team was composed of 6 men, and

Fig. 6225.




*Target (Creedmoor).*

had 15 shots at the distances of 800, 900, and 1,000 yards, making 270 in all for 6 men.

*a*, H. Fulton, American, 58; 800 yards.
*b*, J. B. Hamilton, Irish, 58; 800 yards.
*c*, J. K. Milner, Irish, 57; 800 yards.
*d*, H. Fulton, American, 57; 1,000 yards.
In a possible 60.

The sizes of the targets of the National Rifle Association at Creedmoor are as follows: —

| | Up to 300 yds. | 300 to 600 yds. | 600 to 1,000 yds. |
|---|---|---|---|
| Size | 6 × 2 feet | 6 × 6 feet | 6 × 12 feet. |
| Bull's-eye | 8 × 8 inches | 2 × 2 feet | 3 × 3 feet. |
| Center | 2 × 2 feet | 4 × 4 feet | 6 × 6 feet. |

Bull's-eyes count..... 4.
Centers count..... 3.
Outers count..... 2.

See Rifle.

The following is the complete score of the shooting at Dollymount, Ireland; the targets are shown in Plate LXVIII.

THE AMERICAN TEAM.

| | 800 yds. | 900 yds. | 1,000 yds. | Total. |
|---|---|---|---|---|
| Col. H. A. Gildersleeve | 56 | 56 | 52 | 164 |
| G. W. Yale | 57 | 52 | 51 | 160 |
| Major Henry Fulton | 58 | 57 | 46 | 161 |
| R. C. Coleman | 56 | 48 | 52 | 156 |
| Col. John Bodine | 52 | 59 | 51 | 162 |
| Gen. T. S. Dakin | 58 | 55 | 51 | 164 |
| Total | 337 | 327 | 303 | 967 |

THE IRISH TEAM.

| | | | | |
|---|---|---|---|---|
| Wilson | 58 | 50 | 55 | 163 |
| Hamilton | 56 | 54 | 51 | 161 |
| McKenna | 52 | 44 | 53 | 149 |
| Milner | 55 | 37 | 41 | 133 |
| Johnson | 58 | 54 | 50 | 162 |
| Pollock | 59 | 53 | 49 | 161 |
| Total | 338 | 292 | 299 | 929 |

Total for American team..... 967
Total for Irish team..... 929
Americans over their opponents..... 38

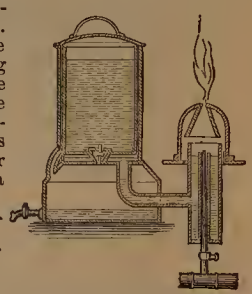
2. The *sight*, sliding on a leveling-staff. Also called a *vane*. See Fig. 2913.

**Tar'la-tan.** (*Fabric.*) A showy, transparent muslin dress-goods.

**Tar-lamp.** A lamp for burning tar for purposes of illumination.

The tar is contained in the cylindrical case, and flows from thence by a pipe to the burner, at whose summit it is ignited. The supply-apparatus is on the fountain-lamp principle, and a chamber below the reservoir catches any overflow, which is drawn off by a faucet. A jet of air is introduced through the center of the annular burner, having a pressure of 1½ pounds to the square inch. This is admitted at pleasure by a faucet below. Without the central blast, a small lambent flame is obtained; when the compressed air is admitted, the tar burns with a vivid white light.

Fig. 6226.



*Beale's Tar-Lamp.*

**Tar-pau'lin.** A cloth of stout canvas, coated with tar or other water-proof compound. Employed on shipboard and ashore for covering hatches, boats, hammocks, etc., and protecting articles generally from the weather.

A tarpaulin, or thick unpainted canvas, sometimes called a *paulin*, forms part of the equipment for each carriage of a field-battery of artillery.

**Tar'rass.** A volcanic earth used in making cement. See Pozzuolana.

**Tarred Line.** (*Nautical.*) Cord which has been tarred, in contradistinction to *white* line.

**Tarred Links.** Used for lighting up forts, trenches, etc. They are made of old rope, well beaten, to soften it, and are covered with a composition of pitch, tar, and mutton-tallow, similar to that used for pitched fascines.

**Tar'ris.** Pozzuolana (which see).

**Tar'sia-work.** A species of inlaying in wood, much practiced in Italy during the Middle Ages, especially for wall-paneling.

Wood in its natural colors was employed in the earlier specimens, but afterward, when more complicated figures, birds, flowers, etc., were introduced, the various pieces were stained; the colors, however, generally lacked permanence. The art was revived some years since in France, and M. Boucherie introduced a method of permanently tinting the wood to a considerable depth. Shades are produced by immersing the pieces in hot sand; the design is built up on paper, and applied in the manner of veneer.

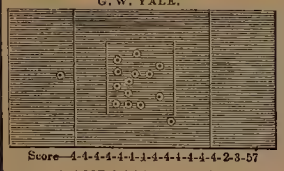
**Tar'tan.** 1. (*Fabric.*) Woolen cloth, cross-barred with stripes of various colors, forming *pancs*, and constituting the peculiar patterns which formerly distinguished the different Scottish Highland clans.

2. (*Nautical.*) A small vessel with one mast and

## THE AMERICAN TEAM.

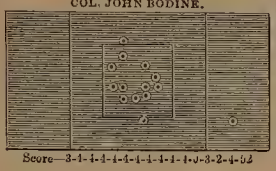
TARGETS AT EIGHT HUNDRED YARDS.

G. W. YALE.



Score—4-4-4-4-4-4-4-4-4-4-4-4-4-2-3-57

COL. JOHN BODINE.



Score—3-4-4-4-4-4-4-4-4-4-4-4-3-2-4-57

MAJOR HENRY FULTON.

Score—4-4-4-4-4-4-4-4-4-4-3-4-4-3-3-58

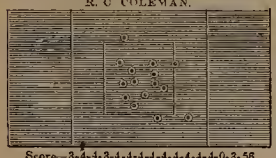
COL. H. A. GILDERSLEEVE.

Score—4-4-3-4-4-3-4-4-4-4-4-3-4-3-3-55

GEN. T. S. DAKIN.

Score—4-4-4-4-4-4-4-3-4-4-4-3-4-4-4-58

R. C. COLEMAN.



Score—3-4-4-3-4-4-4-4-4-4-4-4-4-0-3-56

TARGETS AT NINE HUNDRED YARDS.

G. W. YALE.

Score—3-3-4-3-4-4-2-3-3-4-3-4-4-4-4-52

GEN. T. S. DAKIN.

Score—3-3-4-3-4-4-4-4-4-3-4-4-4-4-3-55

MAJOR HENRY FULTON.

Score—4-4-4-4-4-4-4-3-3-4-4-4-4-4-4-3-57

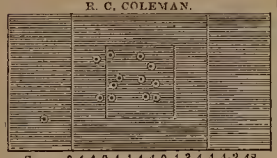
COL. JOHN BODINE.

Score—4-4-4-4-4-4-4-4-4-4-4-4-4-4-3-59

COL. H. A. GILDERSLEEVE.

Score—3-4-4-4-4-4-4-4-4-4-4-3-3-3-3-56

R. C. COLEMAN.



Score—3-4-4-4-0-4-4-4-0-4-3-4-4-4-2-48

TARGETS AT ONE THOUSAND YARDS.

COL. H. A. GILDERSLEEVE.

Score—3-2-3-4-4-3-4-4-4-4-3-3-4-4-3-52

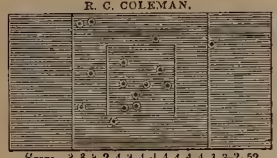
GEN. T. S. DAKIN.

Score—3-4-4-4-4-5-4-4-4-4-4-3-3-0-3-51

MAJOR HENRY FULTON.

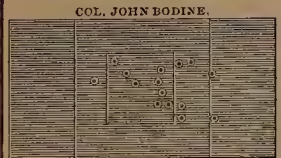
Score—3-2-3-4-4-4-4-0-4-3-0-4-4-4-3-46

R. C. COLEMAN.



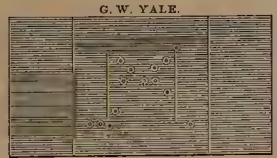
Score—3-3-3-2-4-3-4-4-4-4-4-4-4-3-2-52

COL. JOHN BODINE.



Score—4-3-3-4-4-2-3-4-4-4-4-4-3-3-2-51

G. W. YALE.



Score—3-3-4-4-4-4-4-4-3-4-3-0-3-4-4-51

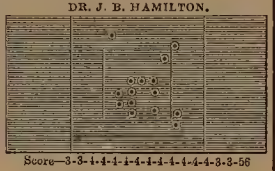
## THE IRISH TEAM.

TARGETS AT EIGHT HUNDRED YARDS.

EDMUND JOHNSON.

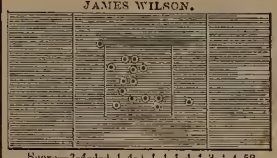
Score—3-3-4-4-4-4-4-4-4-4-4-4-4-4-4-58

DR. J. B. HAMILTON.



Score—3-3-4-4-4-4-4-4-4-4-4-4-4-3-3-56

JAMES WILSON.

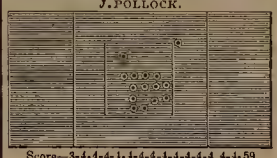


Score—3-4-4-4-4-4-4-4-4-4-4-4-3-4-4-58

J. K. MILNER.

Score—4-4-4-4-4-4-4-4-4-3-4-4-0-4-4-55

J. POLLOCK.



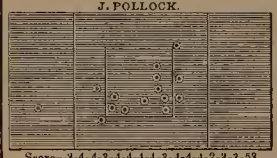
Score—3-4-4-4-4-4-4-4-4-4-4-4-4-4-4-59

JOHN MC. KENNA.

Score—4-4-4-4-4-4-3-4-4-4-4-4-0-3-3-52

TARGETS AT NINE HUNDRED YARDS.

J. POLLOCK.



Score—3-4-4-3-4-4-4-4-3-4-4-4-2-3-3-53

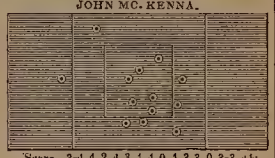
DR. J. B. HAMILTON.

Score—3-3-3-4-4-3-4-4-2-4-4-4-4-4-3-54

J. K. MILNER.

Score—0-3-3-0-4-4-0-4-4-0-4-4-0-4-3-37

JOHN MC. KENNA.

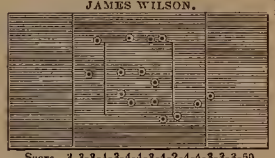


Score—3-4-4-2-4-3-4-4-0-4-3-3-0-3-3-44

EDMUND JOHNSON.

Score—3-4-3-4-4-4-4-3-4-4-3-4-4-3-3-54

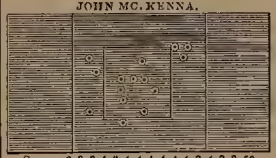
JAMES WILSON.



Score—3-3-3-4-3-4-4-3-4-2-4-4-3-3-3-50

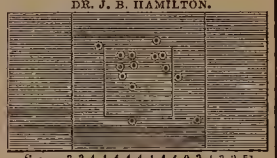
TARGETS AT ONE THOUSAND YARDS.

JOHN MC. KENNA.



Score—3-3-3-4-3-4-4-4-4-4-3-4-3-3-3-53

DR. J. B. HAMILTON.



Score—3-3-4-4-4-4-4-4-4-4-0-4-3-3-3-51

J. K. MILNER.

Score—3-3-3-0-3-4-3-4-4-0-4-4-0-3-5-3-41

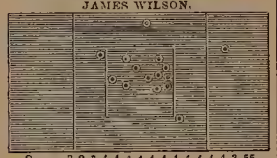
EDMUND JOHNSON.

Score—3-3-3-3-4-4-4-4-4-3-3-3-3-3-3-50

J. POLLOCK.

Score—3-3-3-3-4-4-4-4-3-4-0-3-4-4-3-49

JAMES WILSON.



Score—3-2-3-4-4-4-4-4-4-4-4-4-4-4-3-55

THE TARGETS AT THE INTERNATIONAL RIFLE-MATCH.

*Diagrams showing the Shots made by each contestant of the American and Irish Rifle-Teams at Dollymount, Ireland, June 29, 1875.*

PLATE LXVIII.

*See page 2498.*

a bowsprit, the mainsail being spread by a lateen yard. Used in the Mediterranean.

3. A kind of long covered carriage.

**Tar-ta'ri-an Stove.**

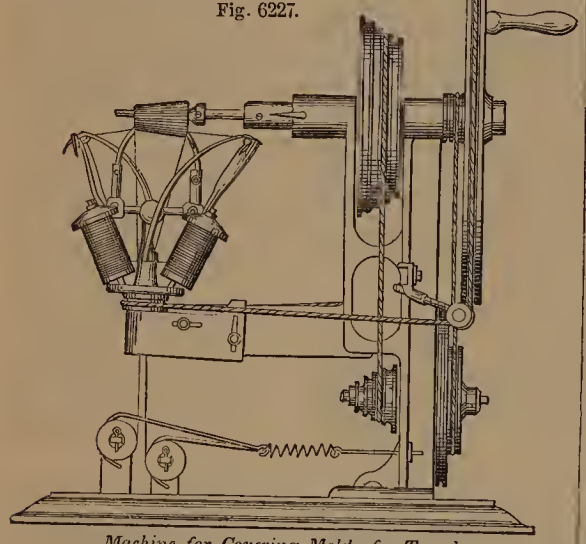
"The *kang*, the sort of large flat stove upon which we slept, was not entirely made of stone, as in the North of China, but partly of movable planks placed one beside the other, so that they join perfectly. When it is desired to heat the *kang*, the planks are taken away, and a quantity of dry and pulverized horse-dung is spread over the interior, and some lighted charcoal thrown upon it. The planks are then replaced, and the fire gradually communicates to the dung, which, once kindled, does not go out again. The heat and smoke, having no outlet [?], soon warm the planks, and produce an agreeable temperature, which lasts the whole night, from the slow combustion of the dung." — ABBÉ HUC, *Travels in Tartary*.

**Tar-well.** (*Gas-works.*) A tank containing water, through which gas is passed to extract the tar. See DIP-PIPE; HYDRAULIC MAIN.

**Tas'sel.** 1. A pendent ornament, usually with fringe, and used on the edges of hangings and the corners of cushions.

Fig. 6227 is a machine for covering molds for tassels. The spools and guides may be readily adjusted to correspond to the taper of the mold to be covered. The wires pass through the guide-hooks, and the threads slide over the outer surfaces of the barbs of the hooks

Fig. 6227.



*Machine for Covering Molds for Tassels.*

in such a manner that the threads are deposited on the wires before the same reach the mold.

2. (*Architecture.*) A board beneath the mantelpiece.

3. A *teasel; Dipsacus fullonum.* See TEASELING-MACHINE.

**Tast'ing-hole.** (*Steel-manufacture.*) A small hole through the bar-trough and the wall of a cementing-furnace, through which a bar of iron may be withdrawn to examine the condition and degree of progress.

**Tat.** (*Fabric.*) Cloth made from the fiber of the *Cochorus olitorius.* See JUTE.

**Tat'ta.** An East Indian name for a frame of finely woven bamboo-splints, which is used as a screen for window-openings, and kept moist by trickling water, so as to cool the air passing through it into the apartment. An *alcarazza.*

**Tat'ting.** A kind of lace edging, consisting of a set of loops strung upon a thread, on which they are afterward pulled up to form a loop-edging.

**Tat'ting-shut'tle.** A small shuttle used in *tatting.*

Fig. 6228 has a sheathed spool with a spring at each end. A tatting-hook at one end of the shuttle may be protruded or sheathed at pleasure.

The shuttle (Fig. 6229) has a pin *b* which is protracted by a thumb-piece to pass a thread through a loop, and is retracted by a spring.

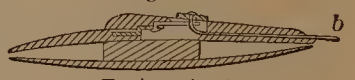
Fig. 6228.

*Tatting-Shuttle.*

**Tat'ting-shut'tle Wind'er.** A device for holding and rotating the tatting-shuttle while the thread is guided between the prongs of the shuttle.

One plate of the shuttle is clamped by sliding sleeves on a bar attached to a rotating shaft in a handle which carries a spool of thread, which is thus transferred to the bobbin of the shuttle.

Fig. 6229.




*Tatting-Shuttle.*

**Tat-too'ing-nee'dle.** (*Surgical.*) An instrument for inserting a pigment beneath the epidermis. Used professionally for coloring white spots in the cornea.

*a*, ordinary tattooing-needle.
*b*, Baader's.
*c*, Agnew's.

Moses alludes to tattooing (Lev. xix. 28). It was the mark of a devotee, was made by a hot iron or by needles, the punctures being filled with powder. The emblem of the deity or the profession was used; the moon, cross, arrow. Branding of slaves, deserters, and even of recruits, was practiced.

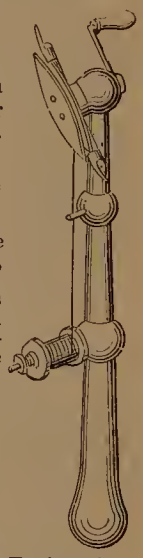
**Tau'ro-col'la.** Glue of bull's-hide.

**Taw.** See TAWING.

**Tawed Leath'er.** See TAWING.

**Taw'ing.** A process of tanning in which mineral agents are substituted for vegetable extracts. The leather produced is known as *Hungarian, white,* or *alum leather;* the latter from the use of alum as the principal agent.

Fig. 6230.



*Tatting-Shuttle Winder.*

Tawing was practiced by the Romans. We read in Isidore of *calcei* (shoes), called *alutæ*, because the skin was softened by alum.

The skins usually subjected to this process are those of the goat, sheep, deer, dog, and some other skins of small size, such as the raccoon, ground hog (woodchuck), fox, etc., some of which are tanned as pelts, retaining the hair.

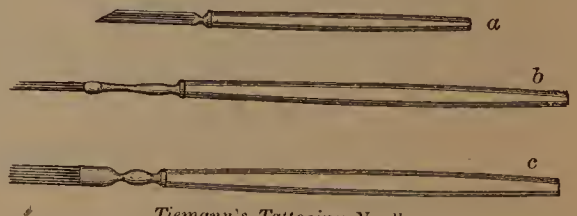
The preliminaries depend upon the purpose for which the skin or pelt is intended; if it be unhaired, the process is accomplished by liming. The skin is then carefully washed and rubbed to remove the lime. The skins are then steeped in a fermenting bran mixture, whose proportions are two pounds of bran to the gallon of water. This develops acetic acid, which neutralizes the lime and swells the skin. The time of steeping is from three days to as many weeks, according to the temperature. The sinking of the skins in the menstruum is the evidence of the completion of the process.

The skins are then steeped in the alum bath, which is thus prepared for 100 sheep-skins: —

| | |
|---|---|
| Alum | 20 pounds |
| Salt | 4½ pounds |

dissolved in hot water, and diluted so as to saturate the skins.

Fig. 6231.




*Tiemann's Tattooing-Needles.*

The skins are tramped in the bath, or subjected to the tumbling operation in a closed revolving cylinder with interior slats.

The skins are then put into a paste made by adding to the alum bath

| | |
|---|---|
| Wheaten flour | 20 pounds |
| Yolks of | 50 eggs |

well mixed. The skins are separately treated with this compound, and then left in it for a night. They are then drawn, suspended on poles, and left to dry, being occasionally stretched.

They are then worked on the softening iron to remove unevenness, develop whiteness, and stretch uniformly. The process is completed by stretching on hooks, rubbing with the stretching-iron occasionally, as the drying proceeds.

The skins may be surfaced with pumice, and glossed with a smoothing-iron.

When the *pelt* is to be dyed, the wool or hair is colored previous to the alum bath.

The coloring of the *skin* is by a tinctorial mixture applied to the grain side while damp, and rubbed in by an iron.

Split horse-hides are made into *tawed*, *white*, or *alum leather*, and are the material for leather aprons used by the mechanics of various arts, the pioneers of the army in full dress, for thongs of whips, and for other purposes.

In Hungary and other countries of Europe, alum-tanned leather, said to be equal to bark-tanned, is used to a considerable extent for harness. The process, it is said, may be completed in 24 hours. Heavy ox or cow hides fresh from the slaughter-house are first well washed in salt and water to remove the blood, and then laid on the beam, flesh side up, and well scraped. The hide is then placed on a smaller beam, and the hair removed with a sharp knife, after which it is placed in a tanning solution of salt and alum pulverized; the hide is well sprinkled with this and rolled up, and, as the liquid oozes out, it is heated and poured over the hide; this process is continued for 24 hours, when the leather is ready to take the grease; using a cold solution produces a firmer and less porous leather, but takes more time, — three or four days, — small quantities of alum being added to the solution each day. After scraping, the leather is colored with logwood and a small proportion of copperas: it is then rubbed with iron-black and dried. It is finally well rubbed in the direction of its length, and smeared with a mixture of equal parts of bog's lard, tallow, and train oil on the flesh side, tallow only being used on the grain side.

**Taz'za.** An ornamental vase with a spreading, flat top.

**T-band'age.** (*Surgical.*) A bandage shaped like the letter T, consisting of a strip of linen attached at right angles to another strip. When two such strips are so attached it is a double T. Used in supporting dressings in diseases of the perinæum, groin, etc.

**Tea-boil'er Cock.** A cock having a T-headed thumb-piece, by turning which its valve is opened or closed.

**Teache.** (*Sugar.*) The smallest evaporating-pan and the one nearest the furnace front. *Tache.* See TACHE.

**Teach'ing-ma-chine'.** A machine invented by Alfred Long of London for purposes of instruction in languages and music.

It consists of a series of cubes inclosed in a box with a glass side; on these cubes are written the words (or notes, in case of music) which it is intended the child shall learn, and then, by turning the handle of the machine, the words appear in various arrangements, and are read off each time, or translated as they appear, by the pupils.

**Tea'gle.** A corruption of *tackle.* A name applied in England to an apparatus for hoisting operatives and material to the upper stories of factories. See HOISTING-MACHINE; MAN-ENGINE.

**Tea'ket-tle.** An ordinary piece of stove furniture for boiling water for infusing tea, etc.

**Team-boat.** (*Vessel.*) A ferry-boat whose paddles are worked by horses on board.

**Team'ing.** 1. (*Steel-manufacture.*) The operation of pouring the molten cast-steel from the crucible into the ingot-mold.

2. (*Civil Engineering.*) The operation of transporting earth from the cutting to the embankment.

3. A certain mode of manufacturing work, which is given out to a boss, who hires a gang or team to do it, and is responsible to the owner of the stock.

In the shoe business, for instance, each man has his part to perform. One *lasts*, another puts on the *outer soles*, another finishes *bottoms*, and still others put on *heels* and finish *edges*, and thus the boot or shoe goes through all these different processes until it is completed, packed in boxes, and returned to the manufacturer. After reaching this point they are rigidly examined, the final "finishing-touches" put on, "cased" up, and marked.

**Team-shov'el.** An earth-scraper. A scoop drawn by horses or oxen, managed by means of handles, and used in removing earth. See EARTH-SCRAPER; SCRAPER.

**Tea'pot.** A vessel in which tea is infused.

The first notice of tea among the "Western barbarians" is perhaps the account given by Herodotus, Book IV. xxi., xxiii.: —

"Beyond the Tanais the region of Scythia terminates, and the first of the nations we meet with are the Sauromatæ, who inhabit a space of fifteen days' journey. . . Beyond these are the Budini, and beyond them a desert of eight days' journey. [Then follows an orderly account of several countries occupied by other nations, then a stony tract, and eventually a people] living at the foot of some lofty mountains [Himalaya]. They live chiefly on the *produce of a tree* which is called the *ponticus;* it is as large as a fig-tree, and has a kernel not unlike a bean. When it is ripe they press it through a cloth; it produces a *thick black liquor* which they call *aschy;* this they *drink, mixing it with milk;* the grosser parts, which remain, they form into balls [brick-tea] and eat."

The worthy chronicler was mistaken as to one point: it was a leaf and not a fruit. Even then he was much nearer to the mark than one of the large whiskey-distillers of Cincinnati, who observed to a lady in the hearing of the author, "Sponges, madam; I believe they grow on trees."

The annals of China place the use of the leaf at a very remote date. It was introduced into Japan in the ninth century A. D., but was not brought to Europe till some seven centuries later. It was about the middle of the seventeenth century (1664) that the East India Company presented to the queen of England a package of two pounds of tea, then valued at forty shillings a pound. About the same time some Russian ambassadors returned to Moscow, bringing some carefully packed green tea, which was esteemed a great delicacy. The overland tea is still the best.

An advertisement in the "Mercurius Politicus," September 30, 1658, is as follows: —

"That excellent and by all physitians approved *China* drink, called by Chineans Tcha, by other nations *tay*, alias *tee*, is sold at the 'Sultana Head' Coffee-house, London."

"I did send for a cup of tee, a China drink, of which I had never drunk before." — PEPYS, 1660.

In 1667 the British East India Company gave their agents an order for "teas of the best kind to the amount of 100 dollars." In 1678 they imported 4,713 pounds, a quantity which appears to have glutted the market for several years. In 1721 the annual import had reached 1,000,000 pounds.

Tea was used in China long before it was cultivated, several varieties of the bush growing wild.

Among the first notices by foreigners of its use — excepting the remarkable one by Herodotus, the father of history, as he has been termed, and his character for truth and veracity becomes more and more established — is the account given by two Mohammedan travelers of the ninth century, translated from the Arabic by Renaudot, "Ancient Accounts": —

"The emperor also reserves to himself the revenues which arise from the salt-mines, and from a certain herb which they drink with hot-water, and of which great quantities are sold in all the cities, to amount to great sums. They call it *sah* (or *tcha*), and it is a shrub more bushy than the pomegranate tree, and of a more taking smell, but it has a kind of bitterness with it. Their way is to boil water, which they pour over the leaf, and this drink cures all kinds of diseases." El Wahab elsewhere describes the infusion as "drunk out of beautiful cups molded of a rare earth, and made almost as transparent as glass."

"These Mohammedan travelers found a country in which letters were cultivated by high and low. There were schools in every town for teaching the poor to write and read, and the masters were paid at the public charge. There was a large literature of printed books. The governmental officers were selected from the literary graduates, and had been for three centuries" (sixth century A. D.). — PROF. SEWALL.

They had also dials, and clocks, moved by weights.

This was the era of Alfred the Great, the most versatile monarch and greatest man of history. It was also the brilliant epoch of the Moorish occupation of Spain, then the gem of Europe. About this time took place the separation of the Greek and Roman churches, and the temporal sovereignty of the latter was assuming its great proportions.

The *brick-tea* or *tile-tea* of China is used universally over Northern Asia and Chinese Tartary. Tea is used as a beverage and also as an ingredient in stews and soups.

"Brick-tea boiled with salt."

"We seated ourselves on a red carpet, and there was soon brought from a neighboring tent, which served as a kitchen, tea with milk, rolls fried in butter [doughnuts], cheese, dried grapes, and sweetmeats."

"Payments in Tartary are made in brick-tea, whether the

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article be a horse, a house, or any other commodity. Five bricks of tea represent an ounce of silver." — ABBÉ HUC, Journey in Tartary, 1844 - 1846.

Another traveler writes: "On the Thibet side of the Himalaya mountains a tribe of wandering traders, called the Hunnias, travel over great distances, living upon brick-tea, which is brought from China, and consists of the coarsest leaves, twigs, and seeds of the tea, pressed by weights into lumps, and rendered more adhesive by a slight admixture of the serum of sheep's blood. Upon this they perform long journeys."

At Kiachta, in 1862, the imports of tea from China amounted in value to 7,748,816 silver roubles, equal in value to $ 5,812,000, as follows: —

| | |
|---|---|
| Tea | 6,851,445 roubles. |
| Brick-tea | 897,371 roubles. |

Fig. 6232, from Hooker's "Himalayan Journal," illustrates a brick of tea, two forms of teapot, and a teacup, used by the Thibetans. A tobacco-pipe, two pouches, flint and steel (which

Fig. 6232.

*Teapots and Brick-Tea (Thibetan Himalaya).*

might readily be mistaken for a knife), and those Oriental substitutes for the knife and fork, the chopsticks, are also shown.

A nourishing mess is prepared from this brick-tea, which is extensively used throughout the colder regions of Asia, by churning up a handful of the leaves with salt, butter, and soda, and boiling the compound, which is served up scalding hot.

Tea is produced in greater or less quantity and perfection in that part of Asia extending from westward of Nepaul to and including the Japanese islands on the east, and embracing in its greatest width more than 20° of latitude, say from 18° to 38° on the continent, and extending to beyond the 40th parallel in Japan. The great center of production, however, is an oval area in the East, lying on each side of the parallel of 30°, extending back some five hundred miles from the coast, its greatest width being somewhat less. Shanghae is on the extreme northeast boundary of this district, where it is terminated by the coast. Attempts have been made, it is said, recently, with considerable success, to introduce the culture of the plant into Ceylon. It has also been cultivated with some success in Northern India.

About 1844, Dr. Junius Smith, of South Carolina, attempted the culture of tea in that State. The plants throve, but the product could not compete in price with that grown by cheap labor in China. In Brazil, the shrub is found to thrive even more luxuriantly than in China, attaining the proportions of a small tree, but the leaf lacks the delicate aroma which distinguishes it on its native soil, becoming harsh and coarse-flavored. Within a few years past it has been naturalized in California, where the climate and soil appear propitious.

Though indigenous in China, the native growth there is not much depended on for a supply. On the contrary, the plant is most carefully cultivated, and affords one chief employment to the people of that vast empire. The plant is grown in almost every variety of soil, but that best adapted to it is a light loam, more or less stony, abounding in vegetable mold, and moist but not wet. The seeds are gathered in October, and kept in sand till the following spring, when they are sown, either in rows in the field where they are to grow, or else in beds, from which they are transplanted; if the latter, they are put out the second year in rows three or four feet apart. In growing, they look not unlike a field of currant-bushes with us. They are hardy, yet if the weather is very cold they need protection; if dry, the cultivators resort to irrigation. The gathering of the leaves sometimes commences the third year, though often not till the fourth. There are three or four harvests, — the first, of leaf buds, early in April, though many prefer to forego this, and allow the leaves to grow. If gathered, these buds make the choicest variety of black tea, known as Pekoe. But new leaves soon appear, and a second gathering occurs the last of April, or early in May, which is the principal harvest, and affords a fine tea as the product. A third gathering occurs early in July, which furnishes leaves of an inferior quality; and sometimes there is a fourth gathering in August or September, which furnishes leaves still coarser and poorer. The plants rarely last more than eight or ten years, when they are dug up and replaced with a new stock. In gathering, the leaves are stripped off with much care, and carried to a building where they are assorted and dried.

The drying process varies as to the kind of tea to be produced, for our varieties of green and black tea are not so much the product of different species or regions as results from different ways of curing the same leaf.

The green teas are cured almost as soon as the leaves are brought from the field, being allowed to remain not more than an hour or two thinly spread upon trays, to dry off any superfluous moisture, before they are put into the roasting-pans. These latter have been in the mean time heated by a brisk fire, and into them are thrown a few of the leaves, which are allowed to remain four or five minutes, rapidly shaken and stirred, when they are thrown out upon a table and rolled with the hands. Afterward they are again thrown into a pan, heated by a slow, steady fire, and allowed to remain an hour or an hour and a half, being kept all the time in motion by the hands of the workmen. Sometimes they are thrown upon a table to be rolled a second time. This completes the chief part of the operation, though afterward, when a considerable quantity has thus been finished, it goes through a farther process of winnowing and sifting to separate impurities, and assorting into different varieties, and reheating also, to be sure that the drying is complete.

Teas for home consumption are never colored. Those for export to Europe and America are made more pleasing to the eye, if not to the palate, by the addition of Prussian blue, China clay, turmeric, and a white powder usually composed of kaolin, soapstone, or sulphate of lime. Black-lead and indigo are also employed for coloring and glazing. Rice or paddy husks mixed with fragments of the tea-leaf, and tea-dust mixed with sand and rice-water, known as "Lie tea," are other factitious products designed to "cheer but not inebriate" the outside barbarian.

The *maté*, or Paraguayan tea, is a holly (*Ilex paraguaiensis*), and is gathered in the woods during the whole year. It is kiln-dried, and then powdered in mortars. In use, a quantity of the leaf is placed in a bowl, steeped awhile in cold water, and then boiling water poured upon it. It is imbibed through a tube to avoid drinking the particles of leaf and stem.

The *yaupon* of the Carolinas, called by the South Carolina Indians the *cassina*, is also an *Ilex* (*I. cassine* or *vomitoria*), and has been used from time immemorial by the Southern Indians, the leaf being a valued article of exchange between the Indians of the coast — where it grows — and the tribes of the interior. It is a stimulant, and acts, according to quantity and the condition of the person, as a diuretic or emetic. It formed the "black drink" of the Indian ceremonials. See Lawton's "Travels in Carolina," London, 1709, pages 90, 91. Also Porcher's "Resources of the Southern Fields and Forests," Charleston, 1869, pages 431 - 433.

It is also used as a substitute for imported tea by the poorer inhabitants of North Carolina in the vicinity of the sounds, and to a small extent forms an article of domestic export.

A list of vegetable substances prepared by infusion for medicinal or stimulating purposes might be extended to an indefinite length. A few of these, in which the mouth acts the part of a teapot, the saliva serving to extract the stimulating principle, form the ordinary solace of no inconsiderable portion of the human race. To say nothing of tobacco, the chewing of which is pretty much confined to the natives of this country, though approaching cosmopolitan universality perhaps among sailors, we have the *betel* of the East Indies, the use of which is very general over a considerable part of the world's surface, and particularly among the Malayan races.

This is prepared from the leaves of several species of pepper, as *Chavica betle*, *Chavica siraboa*, plucked green and spread over with quick-lime (*chunam*), generally prepared from oyster-shells, and wrapped around scrapings of the areca nut (*Areca catechu*). Though too pungent for a European taste, and, it is said, frequently rendering its users toothless by the age of twenty-five, the Malays of all ages generally keep their betel-boxes in requisition from morning till night. It imparts a red color to the saliva and blackens the lips and teeth. Those species of plants of the genus *Chavica*, a division of the pepper family, which yield it, are extensively cultivated. They are climbers, and are trained on poles, trellises, or the stems of palms.

The coca, in general use among the Indians who inhabit the elevated plains among the Andes, is a stimulating narcotic, consisting of the dried leaves of *Erythrosylon coca*, in combination with a peculiar alkaline substance called *clipta*. Provided with a sufficient supply of this drug, an Indian will make an arduous journey of several days' duration without food. Its habitual use is said to be attended with effects analogous to those of opium. The plant is largely grown in the province of La Paz, in Bolivia, forming an important source of wealth to the inhabitants.

A German authority, Von Bibra, in his Preface to "Die narkotischen Genuss-Mittel und der Mensch" (Man and the Use of Narcotics), assumes the following: "Coffee leaves, in the form of infusions, are used by 2,000,000 of human beings; Paraguay tea is consumed by 10,000,000; coca by as many; betel is chewed by 100,000,000; chicory, either pure or mixed with coffee, by 40,000,000; cacao, either as chocolate or in some other form, by 50,000,000; 300,000,000 eat or smoke hashish; 400,000,000 use opium; Chinese tea is drunk by 500,000,000; coffee by 100,000,000. All known peoples of the earth are addicted to the use of tobacco, chiefly in the form of smoking; otherwise as snuffing or chewing."

Alcoholic stimulants are not included in his estimate.

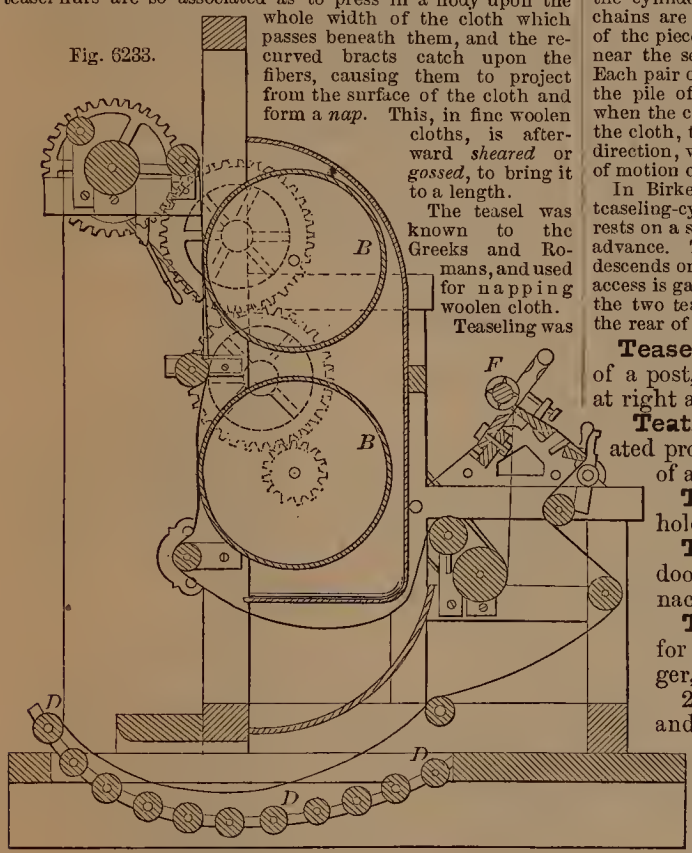
**Tear'ing-ma-chine'.** A machine for disintegrating woven fabric to make fiber for reworking. It usually consists of a cylinder with sharp-pointed teeth that seize the fabric close to the feeding-rollers, and tear and deliver it into a receptacle.

**Tears.** The vitreous drops from the melting of the walls of a furnace.

**Teas'el-ing-ma-chine'.** (*Woolen Manufacture.*) A machine in which woolen cloth is teaseled to raise a nap upon it, the ends of the fibers being exposed and laid in one direction, which forms the grain of the cloth.

The teasel (*Dipsacus fullonum*) has large burs with stiff, hooked awns, which are used in raising a nap on cloth. The teasel-burs are so associated as to press in a body upon the whole width of the cloth which passes beneath them, and the recurved bracts catch upon the fibers, causing them to project from the surface of the cloth and form a *nap*. This, in fine woolen cloths, is afterward *sheared* or *gossed*, to bring it to a length.

Fig. 6233.



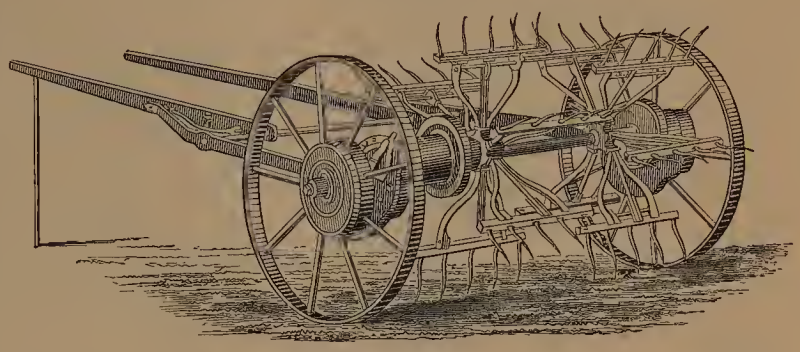

*Teaseling-Machine for Finishing Woolen Cloth.*

The teasel was known to the Greeks and Romans, and used for napping woolen cloth. Teaseling was formerly done by hand; a number of teasel-heads being fixed in a small wooden frame with cross handles. The surface of the cloth was worked first in the direction of the warp and then in that of the weft, the cloth being damped. The teasel-heads were cleaned by children with small combs, and when the teasels became damp they were laid aside to dry.

In the *gig-mill* the teasels are arranged in long frames attached to a hollow rotating cylinder, and the cloth by means of rollers is moved in a direction opposite to that of the cylinder, superseding the hand method. See GIG-MILL.

Oldland's teaseling-machine, English patent, 1830, consists of a horizontal, revolving *teasel-frame*, furnished on its under side with teasels, wire-cards, brushes, or other materials used in dressing, or raising the pile of the cloth. The revolving teasels are put in motion by a band on the spindle; and as the cloth is brought under the teasels by conducting rollers, it is pressed up against them by supporters covered with elastic material. There are two teasel-frames in the breadth of the goods, and each of these has a motion from the middle of the goods to the selvage and back again, so that the operation on the cloth is not rectilinear, but by the end motion of the cloth the lines of action continually cross each other at fine angles.

Fig. 6234.



*English Hay-Tedder.*

Ferrabee's teaseling-machine, English patent, 1830, employs two series of teasels, each attached to an endless chain, which passes around two cylinders, by which it is put in motion, the pile being raised from the middle sloping to the sides. Two of the cylinders which support and give motion to the teasel-chains are placed with their axes extending along the middle of the piece of cloth, and the other two cylinders are placed near the selvages of the cloth with their axes parallel thereto. Each pair of cylinders is made to turn in a direction to raise the pile of the cloth from the middle toward the selvages, when the cloth is at rest; but when an end motion is given to the cloth, the line of action of the teasels assumes an angular direction, whose obliquity is determined by the respective rates of motion of the teasels and the cloth.

In Birkenshaw's machine (Fig. 6233), the axes of the two teaseling-cylinders *B B* are in one vertical plane. The cloth rests on a series of rollers *D D D*, allowing but not forcing its advance. The cloth, after passing over the upper feed-rollers, descends on a series of rollers and goes under a bridge *F*, where access is gained to it by the attendant as it runs in contact with the two teaseling-cylinders. A shearing-cylinder is placed in the rear of the lower teaseling-cylinder.

**Tease-ten'on.** (*Joinery.*) One on the summit of a post, to receive two beams meeting each other at right angles.

**Teat.** (*Mechanics.*) A small, rounded, perforated projection, otherwise called a *nipple*, as that of a gun.

**Tea-urn.** A metallic, vase-shaped vessel to hold hot water for replenishing the teapot.

**Teaze-hole.** (*Glass.*) (Fr. *tizard*, "fire-door.") The fuel-opening in the glass-furnace.

**Ted'der.** 1. A rope, strap, cord, or lariat, for fastening an animal by the head to a manger, post, or stake. See TETHER.

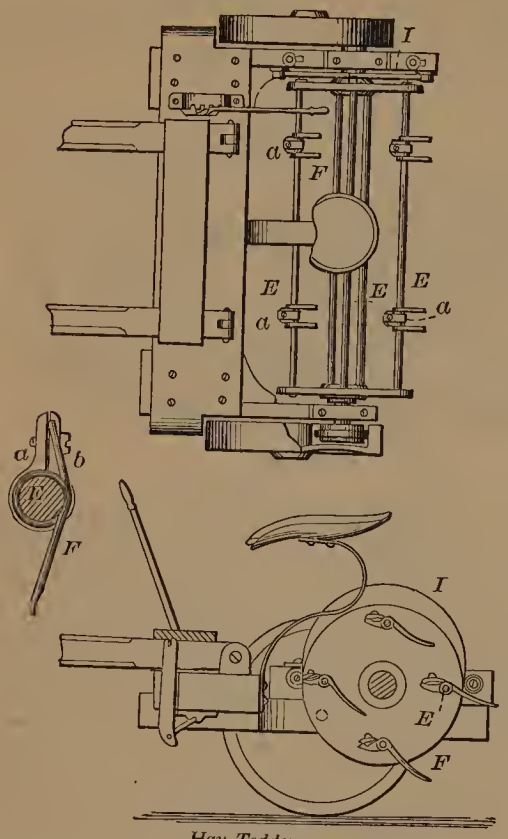
2. (*Agriculture.*) A machine for stirring and spreading hay, to expedite its being dried by the sun and air. See HAY-TEDDER.

The English hay-tedder (Fig. 6234) has two separately rotating cylinders, and is so arranged that the action of the barrels may be easily reversed, so that after the grass has been strewn in the usual way, by reversing the motion, throwing it backward, it is laid very lightly and loosely, permitting more free access of air for drying.

Tedders are classed as *Reels*, *Kickers*, and *Endless* belts, according to their mode of action.

In Fig. 6235, the bars *E* carrying the tedder teeth *F* are connected by cranks to a revolving ring *I* which is confined between two rollers, and so arranged as to cause the teeth to point in the same direction during their entire revolution with the tedder-frame. Screw-clamps *a b* secure the teeth upon the tedder-bars.

Fig. 6235.




*Hay-Tedder.*

**Tedge.** The *ingate* or aperture in a mold through which the molten metal is poured. The metal hardened therein is a *sprue*, or *waster*.

**Tee.** A T-shaped pipe-coupling, adapted for a stem-pipe and two branches.

**Tee-ir'on.** A rod with a cross-bar at the end, for withdrawing the lower valve-box of a pump.

**Teem'ing-punch.** One for *starting* or driving a bolt out of a hole. A *drift*.

**Teest.** A stake or small anvil used by sheet-iron workers. See STAKE.

**Teeth.** The plural of tooth.

It signifies a row of wires, prongs, or projecting pieces, which have various forms and duties in different tools, implements, and machines, as, —

The teeth of a comb, rake, saw, file, etc.

The wires of a carding-machine or curry-card.

The cog of a gear-wheel.

The tine of a fork. See TOOTH.

Specifically: The lower zone of facets of a *rose-cut* diamond, forming a truncated, pyramidal base for the *crown*, or projecting portion. See DIAMOND.

**Teg'u-la.** A roofing-tile.

**Tein'o-scope.** A name given by Sir David Brewster to the prism-telescope.

If a prism be placed horizontally with the refracting edge downward, so that the visual rays from an object enter and emerge from it at equal angles, the object will appear of its natural size; if the refracting edge be turned toward the object, this will appear to be elongated or magnified vertically. A similar prism placed vertically magnifies the object in the direction of its width; and a combination of the two gives an image enlarged in both directions, but fringed with the prismatic colors. This may be corrected by making the prisms of a glass which only transmits one color; by viewing the fringed image through a piece of glass of this kiud; or, what is better for most purposes, by using a second pair of similar prisms placed in reversed directions to the first.

Professor Amici, of Modena, used a combination of four rectangular prisms, having their refracting angles different and connected in pairs; the pair nearest the edge are vertical, and the second pair horizoutal, so as to produce equal refraction in each direction, the magnifying power being about three times. This plan is well adapted for ordinary glasses.

**Tel-a-mo'nes.** (*Architecture.*) Male figures serving as columns or pilasters. Somewhat similar are *Atlantes*, *Persians*, *Caryatides*, etc.

**Tel'e-graph.** In a general sense, the word *telegraph* includes all modes of communicating intelligence to a distance. The modes may be classified as,—

1. Visible.
2. Audible.
3. Tangible.

1. Of the first are: —

*a.* *Semaphores;* moving or posturing arms (*Chappe's; Pasley's; Popham's*).

*b.* Arrangement of disks, triangles (*Edgeworth's*), lanterns, arbitrary characters (*Hook's*).

*c.* Waving flags or torches (*Polybius*) by day or night.

*d.* Various flags disposed on signal halyards (*Marine Code*).

*e.* Colored lights.

*f.* Rockets varying in number or variety.

*g.* Intermittent flashes of light, from a mirror (*heliotrope*), or a lantern.

*h.* Puffs of smoke, according to a code.

*i.* A moving pointer acting by electric impulse (*Wheatstone and Cooke's telegraph*).

*j.* An adjustable column of liquid (*Percival's hydraulic telegraph*).

*k.* The printing (*House, Hughes*), dottiug, and marking a traveling ribbon (*Morse*), chemical paper (*Bain*), and autographic (*Caselli, Bonelli*) telegraphs, which imprint or impress visible characters on paper.

*l.* The electric telegraph, read by the passage of sparks to a conductor (*Bain*).

2. Of the *audible* may be enumerated: —

*a.* The clicking (*Morse apparatus*) and its imitations.

*b.* A bell actuated by electric connections (*Bell*). (*The telegraphic sounder.*)

*c.* Mechanical, noisy devices; horns, gongs, drums, trumpets, whistles, clappers; some actuated by machinery, as alarms, especially for marine *fog-alarms*. See SIREN.

*d.* Firing of guns; varied as to intervals or rapidity.

3. Among the *tangible* may be stated: —

*a.* The Morse instrument read by the pulsations of the armature.

*b.* An electric telegraph read by the shock transmitted.

The subject of telegraphs is considered under various special titles, and detailed description of each at this place would involve repetition.

See under the following heads: —

Acoustic telegraph.
Alphabet-telegraph.
Annunciator.
Astatic needle.
Autographic telegraph.
Bank-alarm.
Battery.
Beacon.
Bell-telegraph.
Chemical-priuting telegraph.
Circuit.
Circuit-breaker.
Circuit-closer.
Commutator.
Copying-telegraph.
Current-regulator.
Disk-telegraph.
Duplex telegraph.
Earth-battery.
Earth-plate.
Electric bridge.
Electric cable.
Electro-chemical telegraph.
Electro-magnetic telegraph.
Field-telegraph.
Fire-alarm telegraph.
Galvanic battery.
Galvanometer.
Galvanometric multiplier.
Heliotrope.
Hydraulic telegraph.
Indicator.
Indicator-telegraph.
Insulator.
Line-wire.
Magneto-electric telegraph.
Manipulator.
Mechanical telegraph.
Needle-telegraph.
Optical telegraph.
Pantelegraph.
Paragrandine.
Paragrele.
Pneumatic telegraph.
Printing-telegraph.
Receiving-magnet.
Recording-telegraph.
Reel-telegraph.
Relay-magnet.
Repeater.
Resistance box.
Resistance-coil.
Semaphore.
Signal.
Solar telegraph.
Sounder.
Submarine cable.
Submarine telegraph.
Switch.
Symbol-printiug telegraph.
Telegraph-alarm.
Telegraph-cable.
Telegraph-clock.
Telegraph-dial.
Telegraphic keyboard.
Telegraph-indicator.
Telegraph-key.
Telegraph-pole.
Telegraph-reel.
Telegraph-register.
Telegraph tariff-indicator.
Telegraph-wire.
Terminal
Type-setting telegraph.
Writing-telegraph.

A brief summary of the principle and general

method of operation of the electro-magnetic telegraph may not be out of place here. The parts common to all the various forms are : —

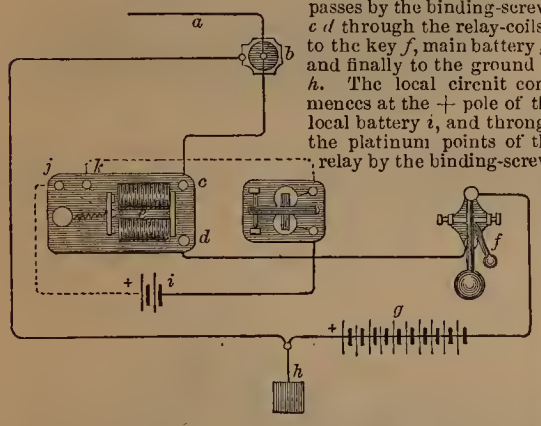
1, a *battery* for generating the electricity : 2, a *wire* for conducting the current; 3, a *transmitting instrument*, by which the circuit is made and broken to cause the intermittent impulses which make the signals; 4, a *receiving instrument*, having a needle or armature which vibrates under the influence of the pulsations of the current.

Various forms of constant battery are used; one is required at each station for transmission, a pole of each being connected by the wire with the opposite pole of the other; the other poles are connected with the earth, which completes the circuit. When so arranged, the batteries are said to be reversed. When connection is made between the line wire and the battery at the transmitting station by means of key, lever, or other contrivance, the current flowing through the electro-magnetic coil at this station passes through the wire to another coil at the receiving station, by which it is intensified, regaining a portion of the force which it had lost by the resistance of the wire, and acquires sufficient power to operate the indicating or recording device, having done which it is conducted away to the earth. A current may thus be transmitted to any distance by having *relay* magnets at proper intervals to restore the strength of the current when it becomes enfeebled. The receiving apparatus at any or all intermediate stations may be included in the circuit, so that the dispatch will be repeated at those points, or it may be thrown out of the circuit, so that it will be received only at the extreme end of the line.

When the transmitting apparatus is out of connection with the battery, the current passing from the pole of one battery to the opposite pole of the other is conducted away to the earth. In some forms of telegraph, however, as the fire alarm, the circuit is continuous through the signaling instrument, the signals being made only when this circuit is broken.

Fig. 6236 shows the arrangement of wires, batteries, and instruments for one of the terminal stations of a line. The line-wire *a* first enters the lightning-arrester *b*, and thence passes by the binding-screws *c d* through the relay-coils *e* to the key *f*, main battery *g*, and finally to the ground at *h*. The local circuit commences at the + pole of the local battery *i*, and through the platinum points of the relay by the binding-screws *j k*, thence through the register or sounder coils *l*, and back to the other pole of the battery.

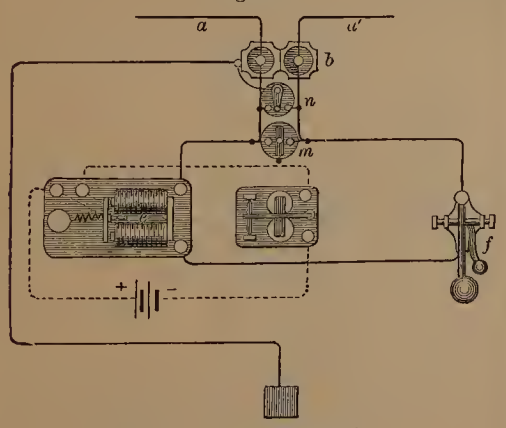
Fig. 6236.




*Arrangement of a Terminal Station.*

Fig. 6237 is a plan of the instruments and connections at a way-station. The line-wire *a* passes through the lightning-arrester *b* to the relay *e*, key *f*, back to the lightning-arrester, and thence to the next station. The local-circuit is arranged similarly to the preceding. *m* is a *cut-out*, which may be turned so as to directly connect the wires leading into and out of the office, allowing the line-current to pass without going through the office. The *ground-switch n* is used to connect the line with the earth on either side of the instruments at pleasure. It is only used in case of accidents or interruptions on the lines.

Fig. 6237.




*Arrangement of a Way-Station.*

Various as are the forms of telegraphs, and the appliances used in their working, they may be divided into a few general classes, dependent on the manner in which their indications are made.

1. The *indicator* or *needle* telegraph, in which the signals are read from the deflections of a needle to the right or left of a median line; such is Wheatstone and Cooke's. The submarine telegraph, where the reflecting galvanometer of Thomson is employed, is a variety of this class.

2. The *disk*, *dial*, or "step-by-step" telegraph, having the letters of the alphabet arranged near the periphery of a disk, which is rotated *step* by *step* until each letter of a word is brought opposite an index. The magneto-electric telegraph of this kind is very convenient for local purposes in cities, requiring no battery and no skill in manipulation.

3. The *recording* telegraph, in which dots and dashes, representing the various letters and numbers, are marked by appropriate mechanism upon a strip of paper, as in the original Morse telegraph.

The *electro-chemical* telegraph of Bain and others belongs to this class.

4. The *printing*-telegraph, by which the letters are printed in ink upon a strip of paper, each from its appropriate key at the other end of the line. Such are those of Hughes, House, and others.

5. The *autographic* telegraph, which makes an exact facsimile of the message sent upon a prepared sheet of paper, as those of Caselli and Bonelli. This is a peculiar modification of the electro-chemical telegraph.

6. The *automatic* telegraph was invented by Wheatstone in 1858.

In the modern automatic telegraphic process, telegrams, by a device founded on the idea of the Jacquard loom, may now be committed to a roll of paper, punched with holes instead of letters, and dispatched automatically. The punched roll delivers its message to the instrument without attendance, and the message is printed at the other end of the line at the same time. The advantage claimed for this system is a gain of time, and the liberty to send messages when the line is in the most favorable condition without the assistance of the operator.

A larger number and greater variety of ideas can be conveyed with greater exactness in fewer words in the English language than in any other. Its advantage over French or German, for instance, is said to be from 25 to 33 per cent.

The telegraphs of the world are estimated (Hawkshaw) at 400,000 miles, at $ 500 per mile = $ 200,000,000.

The wire is now in all cases, except those of submarine cables, and sometimes in cities, conveyed upon poles. In this country any kind of available wood is used, and in passing through forests the wire is frequently attached to living trees. The poles seldom undergo any treatment for the purpose of preserving them. In England more pains is taken. The timber generally employed is larch treated with sulphate of copper, or red fir creosoted by the Bethel process. When not sulphated or creosoted, they are well seasoned and then painted, the but-ends being slightly charred to a foot above the ground line and tarred. Each pole is provided with an earth-wire or conductor for conveying electricity escaping from the wires in wet weather to the earth. These sometimes project above the tops of the poles, and serve as lightning-arresters.

The poles are also stayed by wire ropes connected to rods inserted in the ground, and in exposed positions double stays are employed.

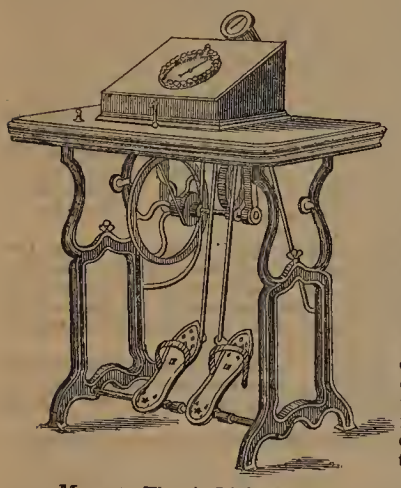
On railway lines the Varley double-cone brown-ware insulator is employed, and on canals and highways the single-cone white-ware or porcelain insulator. The wires are attached to the insulators at every post. What is known as the Britannia joint is exclusively employed for uniting the lengths of wire. This is made by bending the ends of the two wires, placing them side by side for a distance of three inches, binding them together with No. 19 wire, and soldering them.

The *domestic* or *district* telegraph is designed to connect stores, private dwellings, or other houses in cities with a central station, where there is an observer to attend to the messages received. The transmitting instrument is attached to the wall at a convenient place in the house, and connected by a wire leading to the roof, with a wire leading to the station; it is provided with three knobs or levers, one for sounding an alarm of fire, another for summoning a policeman, and a third for indicating that a messenger is wanted. On either of these signals being transmitted, the requirement is at once indicated and attended to at the central office.

Fig. 6238 is a magneto-electric dial-telegraph adapted for railroads and private business purposes. The electricity is generated by working the treadles which rotate the armatures of the magnets. When the crank at the front of the machine is in upright position, as shown, the alarm from a distant station may be received; it is turned to the right when desired to transmit a message; in either diagonal position the circuit is

broken, and when turned to the left the circuit is through the indicator only.

Fig. 6238.



*Magneto-Electric Dial-Telegraph.*

The automatic-alarm telegraph is constructed for "thieves" and for "fire." In one case, the shutters, windows, and doors are so connected with an alarm in an office or the bedroom as to spring an alarm if any of the said objects are tampered with.

In the other case, thermostats are placed at all necessary points, and when at any of these the heat of the room or passage rises a degree or two above the point for which it is set, an electric contact is made and the alarm is sprung.

The following patents of Watkins may be consulted: March 10, 1863; May 10, 1870; January 31, 1871 (six patents); March 28, 1871; October 27, 1874.

The system of *fire-alarm telegraphs*, now so general in large American cities, is referred to on page 849, and the devices on page 1913, REGISTER; page 1918, REPEATER.

One important application of the telegraph is for determining differences of longitude. For this science is largely indebted to Dr. Locke, of Cincinnati, by whom it was successfully practiced as far back as 1848. Cambridge Observatory, Mass., has thus been brought into direct communication with San Francisco by connecting the wire with the pendulum of a clock at Cambridge, so that the main circuit is broken and instantly closed at each oscillation; the moment at which the circuit is broken is noted by the observer at San Francisco, by a clock regulated to local time there, which, being compared with the local time at Cambridge, gives the difference of longitude between the two places. Many other stations, both in Europe and America, have been connected, and their longitudes determined in this way.

The moments of breaking and closing the circuit are practically the same at both places, the velocity with which the current traverses the wire being comparable only to that of light, though Professor O. M. Mitchell determined that a minute though appreciable interval of time elapsed during its passage between two widely separated stations.

The telegraph was first used for military purposes during the Crimean war, 1854–55. Its application for this purpose was greatly extended during our recent civil war, and has now become systematized in the armies of Europe.

In the French army the whole apparatus is carried in a covered carriage, divided into two compartments, one for an office, and the other containing a reel of wire. In the office is a table for supporting the instrument, two accumulators, one for the batteries, and the other for the signal-bells, and a seat for two persons. The reel is supported on its axis in the rear compartment, so that the wire unwinds as the carriage proceeds; it contains 3 kilometres (nearly 2 miles) of wire, and extra reel carriages are provided, each carrying 21 kilometres (over 13 miles) of wire on 7 reels. The wire is composed of 4 copper threads twisted together, and protected by an insulating coating of fiber and india-rubber, so that when laid on the ground it will sustain the passage of vehicles without injury. Poles are used in special cases. Each telegraph-carriage is in charge of a sergeant, two corporals, and twelve men divided into three squads, the first of which goes ahead with the sergeant, traces the line, cuts a trench for the wire, or makes the poles; the second has charge of the reels, and makes the necessary splices, and the third lays the wire or fixes it on the poles. In mountainous countries mules are substituted for the carriage; one carries a small tent, a tripod table, stake, the battery, and tools; another two reels of wire; a third draws a barrow which serves as a reel-frame, which is guided by two men, who carry it in difficult places. See TELEGRAPH-CARRIAGE.

**Tel'e-graph'ic A-larm'.** (*Telegraphy.*) A sounder operated by electro-telegraphic means.

There are many forms:—

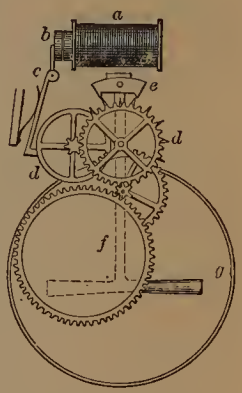
The alarm which runs down, a detent being withdrawn from the escapement. See ACOUSTIC TELEGRAPH, page 11.

The clicking-instrument, operated by successive impulses. This has grown into the ordinary telegraph, which is read by sound.

See also TELEPHONE.

Although Franklin, in 1748, fired spirits by means of a spark transmitted across the Schuylkill, the first distinct plan for a telegraphic alarm to call the attention of an operator or correspondent was by Schweigger, about 1811. He proposed a pistol, charged with a mixture of oxygen and hydrogen gases, to be fired by a spark derived from the long electric wire proceeding from the distant station.

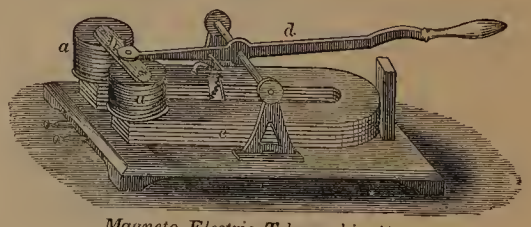
Fig. 6239.



*Telegraphic Alarm.*

Fig. 6239 is an alarm with an escapement. *a* is an electro-magnet; *b* an armature of soft iron, which is attracted as often and as long as the voltaic current circulates through the coil, but is prevented from coming in actual contact therewith by means of two copper studs tipped with ivory. The armature is mounted on the short arm of a lever *c*, which is normally pressed by a spring so as to engage a stop on the wheel *d*, preventing it from moving. When a current passes through the coil, the armature, being attracted, releases the lever from the stop, and clock-work mechanism operating through the escape-wheel *d* upon the pallets *e* causes the hammer *f* to vibrate, striking each side of the bell *g* alternately.

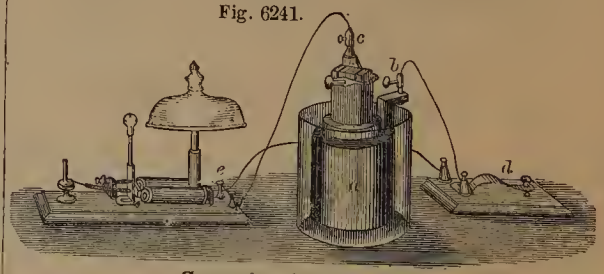
Fig. 6240.



*Magneto-Electric Telegraphic Alarm.*

In Fig. 6240, the hammer is rung without the intervention of an escapement, by means of a current of magneto-electricity. The cores of two coils *a a* are connected by a bar *b*, and serve as keeper to the horseshoe magnet *c*. On depressing the lever *d*, these are raised from the poles of the magnet, creating a current which passes through the coils and along the line to the bell.

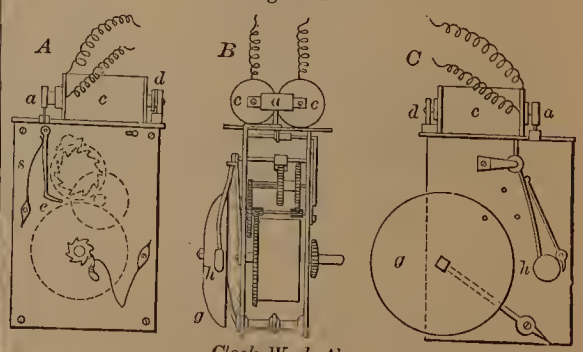
Fig. 6241.



*Connection for Bell-Alarm.*

Fig 6241 exhibits the connections for a bell-alarm *a* is the battery; *b*, the zinc-pole; *c*, the carbon-pole; *d*, the key; *e f*,

Fig. 6242.



*Clock-Work Alarm.*

the binding screws of the bell-magnet. When the key is depressed, the battery current is thrown upon the bell. The three elements of the circuit may of course be separated by any distance within that through which the battery is able to transmit its current. A sounder or register may be substituted for the bell.

In the alarm, of which a side view is shown at *B*, and front and back views at *A C*, Fig. 6242, two electro-magnets *c c*, having their coils connected and wound in similar directions, are joined at one end by a piece *d* of soft iron. At the other end is pivoted a soft iron armature *a*, placed at such a distance as to be strongly attracted by the electro-magnet when the circuit is completed through its coils, and is connected with a detent *e*, which ordinarily engages a fly, but is released when the armature is attracted by the closing of the circuit, allowing a train of clock-work, impelled by a spring or weight to operate, and through the medium of a scape-wheel and pallets, causing the hammer *h* to strike the bell *g*. When the current ceases to flow, the armature is retracted by the spring *s*, again locking the mechanism.

**Tel'e-graph-ca'ble.** (*Electricity.*) The essential features of a submarine telegraph-cable are a wire or wires for conducting and a protecting compound. To these are added sheathing, to protect against abrasion or other injury, and sometimes material to increase the tensional strength of the cable. With these conditions to meet, there have been numerous patents in the United States and in England, but the patents of the latter country are in such a chaotic condition that it is almost impossible to give an intelligent idea of them. The same invention is the subject-matter of numerous patents, and the futility of many of the devices is only exceeded by the utter looseness with which they have been lapped and piled upon each other.

The inventions concern particularly, —

1. The arrangement of the coated wires in clusters with protecting envelope.
2. Wrapping or enveloping in light material to give buoyancy to the cable, and prevent the parting of the wire when laying it in deep water.
3. Modes of connecting and splicing the ends of sections or lengths of wire.
4. Machinery for constructing the cable; that is, putting on its insulating and preserving covering while the wire is paid off from a reel, or reels.
5. Materials for insulating and modes of applying the materials.
6. Coating and preservative materials over the insulated wire, or clusters of wires.
7. Means and modes of storing.
8. Machines for paying out, registering, and laying.
9. Modes of recovering, under-running, and mending.
10. Transmitting and receiving instruments.

The wires are of copper, frequently tinned, and generally coated with gutta-percha, but preferably with india-rubber The details are very varied in different establishments, and for different kinds of cable.

In 1839, Dr. O'Shaughnessy constructed a telegraph-line 21 miles long near Calcutta, embracing 7,000 feet of submerged wire; this was covered with cotton thread saturated with pitch and tar.

Professor Morse is said to have laid a wire between New York and Governor's Island in 1842

In March, 1845, Brooman, in England, patented the method now universally employed for preparing gutta-percha; and in September of the same year Bewley patented a machine for making tubing, hose, etc., on the principle of Tatham's American machine for making lead pipe, patented in 1841.

In 1846, Mr. James Reynolds, of New York, invented a machine for covering iron wire with india-rubber, and in 1848, by the aid of this machine, covered a wire with gutta-percha, which was laid between New York and Jersey City.

Telegraphs of wire coated in this way were extensively introduced into Prussia in 1847–48, and in the latter year a gutta-percha covered wire was laid across the Rhine at Cologne by Dr. Siemens.

The first submarine cable ever laid in the open sea was laid between Dover, England, and Cape Grinez, France, in 1850. It was a single strand of wire, 27 miles in length, covered with gutta-percha, unprotected by any outside coating, and worked only one day. The next cable was also laid between Dover and Calais, in 1851. This cable was covered with iron wire, contained 4 conducting wires, was 27 miles in length and weighed 6 tons per mile. It was a permanent success. The next long cable was laid in 1853, between Dover and Ostend, a distance of 80 miles, contained 6 conducting wires, and weighed 5¾ tons per mile. In 1853 a cable of 1 conducting wire was laid between England and Holland, 120 miles, weighing 1¾ tons per mile. This cable worked for 12 years. From 1853 to 1858, 37 cables were laid down, having a total length of 3,700 miles; of which 16 are still working, 13 worked for periods varying from a week to five years, and the remaining 8 were total failures.

An unsuccessful attempt to lay a telegraph-cable between Ireland and Newfoundland was made by the "Niagara" and "Agamemnon" in 1857. In the succeeding year these vessels joined their cables in mid-ocean, and successfully completed the work. On the 16th of August, a message and reply were transmitted between Queen Victoria and President Buchanan. After 23 days, 400 messages having been transmitted, it was found to have lost its conducting power.

The name of Cyrus W. Field is indissolubly associated with the subatlantic cable enterprise.

The cable of 1858 consisted of a

*Conductor.* A copper strand of 7 wires, 6 laid around 1; weight, 107 lbs. per nautical mile.

*Insulator.* Gutta-percha laid on in 3 coverings; weight, 261 lbs. per nautical mile.

*Outer Coat.* 18 strands of charcoal iron wire, each strand made of 7 wires, twisted 6 around 1, laid equally around the core, which had previously been padded with a serving of tarred hemp.

*Breaking Strain.* 3 tons 5 cwt.; capable of bearing its own weight in a trifle less than 5 miles depth of water.

In 1865, it was attempted to lay a second cable. The operation was intrusted to the monster steamer "Great Eastern," which commenced the work of laying the cable on the 23d of July. After a considerable length had been paid out it parted, and the broken parts could not be recovered. This cable was much stronger than that of 1858, being made up as follows: —

*Conductor.* A copper strand of 7 wires, 6 laid around 1; weight, 300 lbs. per nautical mile; embedded in Chatterton's compound.

*Insulator.* Gutta-percha and Chatterton's compound; weight, 400 lbs. per nautical mile.

*Outer Coat.* 10 solid wires, drawn from homogeneous iron, each wire surrounded with tarred manilla rope, and the whole laid spirally around the core, which had previously been padded with a serving of tarred jute-yarn.

*Breaking Strain.* 7 tons 15 cwt.; capable of bearing its own weight in 11 miles depth of water.

*Length.* 2,300 nautical miles; actually laid, 1,896½ miles.

In 1866 a second attempt was made by the "Great Eastern," resulting in perfect success. She also succeeded in grappling the end of the cable laid the preceding year, and splicing it, so that there were now two lines of transatlantic telegraph. The cable employed on this occasion was similar to that of the year before, but of somewhat greater strength, 8 tons 2 cwt., its length 2,730 nautical miles, of which 1,868½ miles were laid down, part of the remainder being employed in splicing the cable of 1865.

The distance in each case between the two points connected was about 1,600 nautical miles; the depth of water nowhere exceeding 2.7 miles.

The weight of the second laid (British) Atlantic cable was 2,740 cwt. In laying it while the "Great Eastern" was going at the rate of six knots an hour, the cable passes out at an angle of 6¾° only, so that the inclined plane between the ship and the bottom was 17 miles long. The motion of the vessel in rolling, etc., had little effect; the greatest strain never exceeded one tenth of the breaking strength.

The paying-out mechanism consisted of six grooved wheels fitted with brakes; the cable was pressed into the grooves by six riding wheels, also provided with brakes, and kept down by levers and weights on their shafts; these served to keep the cable tight on the paying-out drum, 6 feet 1 inch in diameter, and 1 foot broad; four turns of the cable were taken around this, and it thence passed over a dynamometer wheel, which deflected it by a lever loaded with weights, and finally over a grooved wheel overhanging the stern of the ship. The apparatus subsequently used was similar to this.

The fifth Atlantic cable, between the coast of Ireland and Newfoundland, was laid by the "Great Eastern," assisted by three other steamships, each fitted with laying and picking-up machinery. The work was begun on the 16th June, 1873, and on the 27th the "Great Eastern" reached Heart's Content, Newfoundland, having payed out 1,700 miles of cable in 11 days.

This cable was made at the works of Siemens Brothers, near London, and is composed of a thick central wire, which is passed through a peculiar composition, and afterward surrounded by eleven smaller wires, the whole being cemented together by the composition. It is then coated with gutta-percha, and served with manilla fiber to the diameter of ⅜ of an inch; the whole is then covered with ten iron wires spun on, each wire being previously wrapped with hemp, and afterward passed through two tanks, by which it is coated with tar, and finally coiled away in large tanks until wanted for use.

The following is a list of oceanic cables laid throughout the world up to the close of 1874. Those marked thus * are not working at the present time.

## Ocean Telegraph Cables of the World.

| Date. | From | Length in Miles. | Greatest Depth in Fathoms. |
|---|---|---|---|
| 1850 | *Dover, England, to Calais, France | 25 | 30 |
| 1851 | Dover, England, to Calais, France | 25 | 30 |
| 1852 | Keyhaven to Hurst Castle, England | 3 | 20 |
| 1852 | Holyhead, Wales, to Howth, Ireland | 65 | 83 |
| 1852 | Port Patrick, Scotland, to Donaghadee, Ireland | 15 | 160 |
| 1852 | Prince Edward Island to New Brunswick | 12 | 18 |
| 1853 | Denmark across the Belt | 18 | 15 |
| 1853 | Dover, England, to Ostend, Belgium | 76 | 3 |
| 1853 | Port Patrick, Scotland, to Donaghadee, Ireland | 25 | 160 |
| 1853 | *England to Holland | 115 | 23 |
| 1854 | Port Patrick, Scotland, to Whitehead, Ireland | 27 | 150 |
| 1854 | Swedeu to Denmark | 12 | 14 |
| 1854 | *Corsica to Sardinia | 10 | 20 |
| 1854 | *England to Holland | 120 | 30 |
| 1854 | *Holyhead, Wales, to Howth, Ireland | 65 | 80 |
| 1854 | *Spezzia, Italy, to Corsica | 110 | 325 |
| 1854 | Holyhead, Wales, to Howth, Ireland | 65 | 83 |
| 1855 | *Sardinia to Africa | 50 | 800 |
| 1855 | *Cape Ray, Newfoundland, to Cape North, Cape Breton | 74 | 330 |
| 1855 | *Sardinia to Africa | 160 | 1,500 |
| 1855 | *Varna, Turkey, to Balaclava, Crimea | 310 | 300 |
| 1855 | *Eupatoria, Crimea, to Balaclava, Crimea | 60 | 69 |
| 1855 | *Varna, Turkey, to Kilia, Roumania | 179 | 30 |
| 1855 | *Italy to Sicily | 5 | 27 |
| 1855 | *England to Holland | 123 | 23 |
| 1855 | *England to Holland | 119 | 23 |
| 1856 | *Cape Ray, Newfoundland, to Cape North, Cape Breton | 85 | 300 |
| 1856 | Prince Edward Island to New Brunswick | 12 | 14 |
| 1856 | *Crete to Alexandria, Egypt | 350 | 1,350 |
| 1856 | Crete to Syra | 170 | 1,020 |
| 1856 | St. Petersburg to Cronstadt, Russia | 10 | 10 |
| 1856 | Across Amazon | 105 | — |
| 1857 | *Sardinia to Bona, Africa | 150 | 1,500 |
| 1857 | *Sardinia to Malta | 500 | 1,000 |
| 1857 | *Corfu to Malta | 500 | 1,000 |
| 1857 | *Portland, England, to Alderney | 69 | 60 |
| 1857 | *Alderney to Guernsey | 17 | 44 |
| 1857 | *Guernsey to Jersey | 15 | 60 |
| 1857 | Ceylon to Hindostan | 30 | 45 |
| 1857 | Ceylon to Hindostan | 30 | 40 |
| 1858 | *Italy to Sicily | 8 | 40 |
| 1858 | England to Holland | 129 | 27 |
| 1858 | *England to Emden, Germany | 280 | 28 |
| 1858 | *Ireland to Newfoundland | 2,036 | 2,400 |
| 1858 | *Turkey to Smyrna *via* Archipelago | 565 | 1,100 |
| 1859 | *Crete to Alexandria, Egypt | 150 | 1,600 |
| 1859 | *Singapore to Batavia | 630 | 20 |
| 1859 | Denmark to Heligoland | 46 | 28 |
| 1859 | *Cromer, England, to Heligoland | 328 | 30 |
| 1859 | Isle of Man to Whitehaven, England | 36 | 30 |
| 1859 | Sweden to Gottland | 64 | 70 |
| 1859 | Folkestone, England, to Boulogne, France | 24 | 30 |
| 1859 | Malta to Sicily | 60 | 75 |
| 1859 | Jersey to Pirou, France | 21 | 10 |
| 1859 | *Otranto, Italy, to Aviano, Turkey | 50 | 400 |
| 1859 | *Ceuta, Africa, to Algesiras, Spain | 25 | 700 |
| 1859 | *Cape Otway, Circular Head | 240 | 60 |
| 1860 | Great Belt, Denmark (2 cables) | 14 | 18 |
| 1860 | *Dacca, Hindostan, to Pegu | 116 | 50 |
| 1860 | *Port Vendres, France, to Algiers | 520 | 1,585 |
| 1859 and 1860 | *Sucz, Egypt, to Cassire, Egypt | 255 | Shallow water |
| 1860 | *Suakin, Red Sea, to Cassire | 474 | Shallow water |
| 1860 | *Suakin, Red Sea, to Aden, Arabia | 627 | Shallow water |
| 1860 | *Aden, Arabia, to Hellania, Arabia | 718 | Shallow water |
| 1860 | *Hellania, Arabia, to Muscat, Arabia | 486 | Shallow water |
| 1860 | *Muscat, Arabia, to Kurrachee, India | 481 | Shallow water |
| 1860 | *Barcelona, Spain, to Mahon, Minorca | 198 | 1,400 |
| 1860 | *Minorca to Majorca | 35 | 250 |
| 1860 | *Iviza to Majorca | 74 | 500 |
| 1860 | St. Antonio to Iviza | 76 | 450 |
| 1861 | Corfu to Otranto, Italy, about | 90 | 1,000 |
| 1861 | *Malta to Tripoli, Africa | 230 | 335 |
| 1861 | *Tripoli, Africa, to Bengazi, Africa | 508 | 420 |
| 1861 | *Bengazi, Africa, to Alexandria, Egypt | 593 | 80 |
| 1861 | Dieppe, France, to Newhaven, England | 80 | 25 |
| 1861 | *Toulon, France, to Corsica | 195 | 1,550 |
| 1862 | Wexford, Ireland, to Aberman, Wales. | 63 | 50 |
| 1862 | Lowestoft, Eng., to Zandvoort, Holland | 125 | 27 |
| 1863 | *Cagliari, Sardinia, to Sicily | 211 | 1,025 |
| 1864 | *Cartagena, Spain, to Oran, Africa | 130 | 1,420 |
| 1864 | Gwadur, India, to Elphinstone Inlet, India | 357 | 437 |
| 1864 | Mussendom, Persia, to Bushire, Persia | 393 | 97 |
| 1864 | Bushire, Persia, to Fao, Persia | 154 | 19 |
| 1864 | Gwadur, India, to Kurrachee, India | 246 | 670 |
| 1864 | Otranto, Italy, to Aviano, Turkey | 50 | 347 |
| 1865 | *Bona, Africa, to Sicily | 270 | 250 |
| 1865 | Trelleborg to Rugén, Germany | 55 | 80 |
| 1865 | South Forelaud, England, to Cape Grinez, France | 25 | 30 |
| 1866 | Ireland to Newfoundland | 1,896 | 2,424 |
| 1866 | Ireland to Newfoundland | 1,852 | 2,424 |
| 1866 | Lyall's Bay to White's Bay | 41 | 50 |
| 1866 | Crimea to Circassia | 40 | .. |
| 1866 | Colonia to Buenos Ayres | 30 | 4 |
| 1866 | England to Hanover | 224 | 27 |
| 1866 | Cape Ray, Newfoundland, to Aspee Bay, Cape Breton | 91 | 200 |
| 1866 | Leghorn, Italy, to Corsica | 65 | 100 |
| 1866 | Persian Gulf | 160 | 110 |
| 1866 | *Khios to Crete | 200 | 1,200 |
| 1867 | South Foreland, England, to La Panne, France | 47 | 28 |
| 1867 | Malta to Alexandria, Egypt | 925 | 2,000 |
| 1867 | Havana to Key West, Florida | 125 | 20 |
| 1867 | Key West to Punta Russia, Fla | 120 | 20 |
| 1867 | Placentia, Newfoundland, to St. Pierre | 112 | 76 |
| 1867 | St. Pierre to Sydney, Cape Breton | 188 | 250 |
| 1867 | Arendal, Norway, to Hirtshalts, Denmark | 66 | 110 |
| 1868 | Italy to Sicily | 5 | 40 |
| 1868 | Havana to Key West, Florida | 125 | .. |
| 1869 | Peterhead, Scotland, to Egursaud, Norway | 250 | 70 |
| 1869 | Grisselhaunn, Sweden, to Nystadt, Russia | 96 | 47 |
| 1869 | Newbiggin to Sondervig | 334 | 48 |
| 1869 | *Black Sea | 300 | .. |
| 1869 | *Scilly Isles to Land's End, England | 27 | 40 |
| 1869 | Malta to Sicily | 54 | 75 |
| 1869 | Tasmania to Australia | 176 | .. |
| 1869 | Scilly Isles to Land's End, England | 27 | 42 |
| 1869 | *Corfu to Santa Maura | 50 | 160 |
| 1869 | *Santa Maura to Ithaca | 7 | 180 |
| 1869 | Ithaca to Cephalonia | 7 | .. |
| 1869 | *Cephalonia to Zante | 10 | 60 |
| 1869 | Bushire, Persia, to Jask | 505 | 97 |
| 1869 | Brest, France, to St. Pierre | 2,584 | 2,760 |
| 1869 | St. Pierre to Duxbury, U. S. | 749 | 259 |
| 1869 | Moen to Bornholm, Sweden | 80 | 28 |
| 1869 | Bornholm, Sweden, to Libau | 230 | 62 |
| 1870 | Scotland to Orkney Isles | .. | 37 |
| 1870 | Salcombe, England, to Brignogan, France | 101 | 59 |
| 1870 | Beachy Head to Cape Antifer | 70 | 34 |
| 1870 | Suez, Egypt, to Aden, Arabia | 1,460 | 968 |
| 1870 | Aden, Arabia, to Bombay | 1,818 | 2,060 |
| 1870 | Porthcurno, England, to Lisbon | 823 | 2,625 |
| 1870 | Lisbon to Gibraltar | 331 | 535 |
| 1870 | Gibraltar to Malta | 1,120 | 1,450 |
| 1870 | *Porthcurno to Mid Channel | 65 | 62 |
| 1870 | Marseilles, France, to Bona, Africa | 447 | 1,600 |
| 1870 | Bona, Africa, to Malta | 386 | 650 |
| 1870 | Madras to Peuang | 1,408 | 1,284 |
| 1870 | Penang to Singapore | 400 | 36 |
| 1870 | Singapore to Batavia | 557 | 22 |
| 1870 | Malta to Alexandria, Egypt | 904 | 1,440 |
| 1870 | Batabano, Cuba, to Sautiago, Cuba | 520 | .. |
| 1870 | Jersey to Guernsey | 16 | 32 |
| 1870 | Guernsey to Alderney | 18 | 30 |
| 1870 | Santa Maura to Ithaca | 7 | 180 |
| 1870 | Zante to Trepito | 11 | 235 |
| 1870 | Sunium to Thermia | 25 | 160 |
| 1870 | Patras, Greece, to Lepanto | 2 | 20 |
| 1870 | Dartmouth, England, to Guernsey | 66 | 58 |
| 1870 | Guernsey to Jersey | 15 | 32 |
| 1870 | Porto Rico to St. Thomas | 110 | 22 |
| 1870 | Santiago, Cuba, to Jamaica | 140 | .. |
| 1870 | Portpatrick, Scotland, to Donaghadee, Ireland | 25 | 160 |
| 1871 | Javea to Iviza | .. | 430 |
| 1871 | Majorca to Minorca | 35 | 93 |
| 1871 | Villa Real to Gibraltar | 155 | 84 |
| 1871 | Marseilles, France, to Algiers, Africa | 447 | 1,625 |
| 1871 | Singapore to Saigon, Cochin China | 620 | 60 |

| Date. | From | Length in Miles. | Greatest Depth in Fathoms. |
|---|---|---|---|
| 1871 | Saigon to Hong Kong | 975 | 630 |
| 1871 | Hong Kong to Shanghai | 1,100 | 42 |
| 1871 | Shanghai, China, to Nagasaki, Japau | 1,200 | 135 |
| 1871 | Nagasaki to Vladivostock, Siberia | | 80 |
| 1871 | Rhodes to Marmarice | 22 | .. |
| 1871 | Latakia to Cyprus | 86 | .. |
| 1871 | Samos to Scala Nuova | 11 | 82 |
| 1871 | Myteleni to Aivali | 13 | 33 |
| 1871 | Khania to Retimo | 32 | 200 |
| 1871 | Retimo to Khandia | 41 | 152 |
| 1871 | Khandia to Rhodes | 201 | 600 |
| 1871 | Khios to Chesmeh | 6 | 33 |
| 1871 | Zaute to Corfu | 150 | .. |
| 1871 | Zante to Cephalonia | 18 | 203 |
| 1871 | Lowestoft, England, to Greitseil, Germany | 223 | 23 |
| 1871 | Anjer, Java, to Telok Betong, Sumatra | 55 | 50 |
| 1871 | Banjoewangie, Java, to Port Darwin, Australia | 1,082 | 1,580 |
| 1871 | St. Thomas to St. Kitts | 133 | 1,170 |
| 1871 | St. Kitts to Antigua | 90 | 130 |
| 1871 | Antigua to Demerara, connecting the West India Windward Islands | 1,028 | |
| 1871 | Porto Rico to Jamaica | 582 | |
| 1872 | Lizard, England, to Bilbao, Spain | 460 | |
| 1872 | British Columbia to Vaucouver Island | 18 | |
| 1873 | Falmouth to Lisbon | 850 | |
| 1873 | Caithness to Orkney | 8 | |
| 1873 | Valentia to Newfoundland | 1,900 | |
| 1873 | Key West to Havana | 125 | |
| 1873 | Placentia, Newfoundland, to Sydney, Cape Breton | 300 | |
| 1873 | Heligoland to Cuxhaven, Germany | 40 | |
| 1873 | England to Denmark | 350 | |
| 1873 | France to Denmark | 450 | |
| 1873 | Denmark to Sweden | 12 | |
| 1873 | Pernambuco, Brazil, to Para, Brazil | 1,080 | |
| 1873 | Alexandria, Egypt, to Crete | 390 | |
| 1873 | Candia to Zante | 240 | |
| 1873 | Zante to Otranto, Italy | 190 | |
| 1873 | Alexandria, Egypt, to Brindisi, Italy | 930 | |
| 1874 | Lisbon to Madeira | 633 | |
| 1874 | Madeira to St. Vincent, Cape de Verd Islands | 1,260 | |
| 1874 | St. Vincent to Pernambuco, Brazil | 1,953 | |
| 1874 | Jamaica to Colon, South America | 660 | |
| 1874 | Pernambuco, Brazil, to Bahia, Brazil | 450 | |
| 1874 | Bahia, Brazil, to Rio Janeiro | 1,240 | |
| 1874 | Italy to Sicily | 7 | |
| 1874 | Jamaica to Porto Rico | 582 | |
| 1874 | Rio Janeiro to Rio Grande do Sul | 840 | |
| 1874 | Rye Beach, U. S., to Tarr Bay, Nova Scotia | 550 | |
| 1874 | Barcelona, Spain, to Marseilles, France | 200 | |
| 1874 | Shetland to Orkney | 60 | |
| 1874 | Valeutia to Newfoundland | 1,900 | |

United States vessels have lately been employed in taking soundings for the Pacific cable.

When this line of telegraph is laid, its length between the terminal points, namely, San Francisco and Yokohama, will be 5,573 nautical miles. The cable will, however, be divided into three sections, — from San Francisco to Honolulu, 2,093 miles; from Honolulu to Midway Island, 1,220; and from Midway Island to Yokohama, 2,260 miles.

*a*, Fig. 6243, is the Ohio River cable. It is composed of an interior wire of No. 10 Swedish iron, surrounded by three coats of gutta-percha and three of Osnaburg, the whole inclosed in No. 10 longitudinal wires, and lashed with one of similar size.

*b* is the Hudson River cable. It has three No. 10 conducting wires, each insulated by a gutta-percha covering inclosed in the same material, and is wrapped with tarred yarn.

*c* is an improvement on this, the wires being separated by solid gutta-percha incorporated in one mass with that which envelops all three. This is covered with tarred hempen twine.

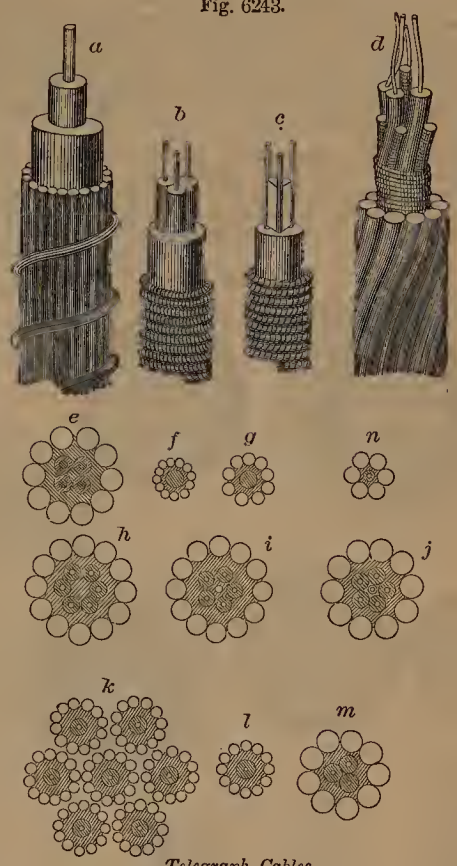
*d e* is the Dover and Calais cable, the first of importance laid in Europe, composed of four interior copper wires surrounded by gutta-percha covered with spun yarn. Ten galvanized wires were then twisted around the whole. Its length was 25 miles.

The next in order of time was the Holyhead and Howith cable, connecting England and Ireland. This had but one conducting wire. The shore ends were larger than those laid in deep water; *f* and *g* show the relative sizes. The distance between the two connected points is 60 miles; 10 additional miles of cable were constructed to meet contingencies.

*h* is the cable which it was attempted to lay down between Portpatrick and Donaghadee, Scotland and Ireland, in 1851. Owing to a gale, it was cut when 16 miles had been paid out. It was subsequently recovered in 1854, the depth of water being 150 fathoms, and found in good preservation.

*i* and *j* are the cables connecting Dover and Ostend, and Portpatrick and Donaghadee. These two cables are precisely similar in size and general construction, each having six wires; some improvements, however, have been introduced into the latter.

Fig. 6243.




*Telegraph-Cables.*

*k* is the shore end of the cable between Orfordness and the Hague. Each cable is composed of a single wire, the whole being brought together near the shore and twisted into one.

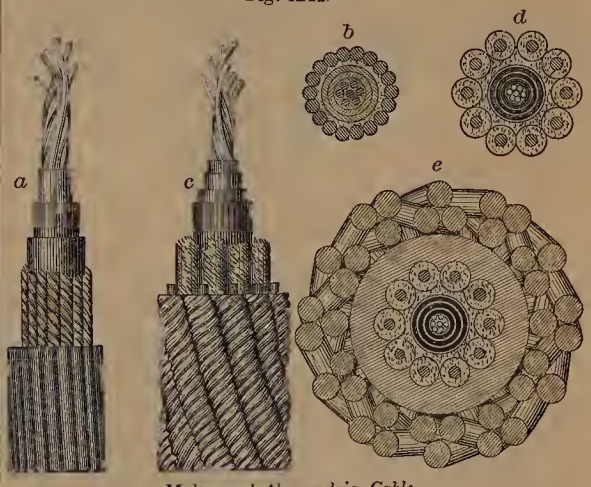
*l*, the cable between Prince Edward's Island and New Brunswick.

*m*, that across the Great Belt, in Denmark.

*n*, that across the Mississippi at New Orleans, on the Balize line.

The Malta and Alexandria cable (*a b*, Fig. 6244) is composed of seven copper conducting wires, over which are three layers of gutta-percha and one of tarred yarn, the whole inclosed by eighteen iron wires. The diameter of the deep-sea portion is .85 inch.

Fig. 6244.




*Malta and Alexandria Cable.*

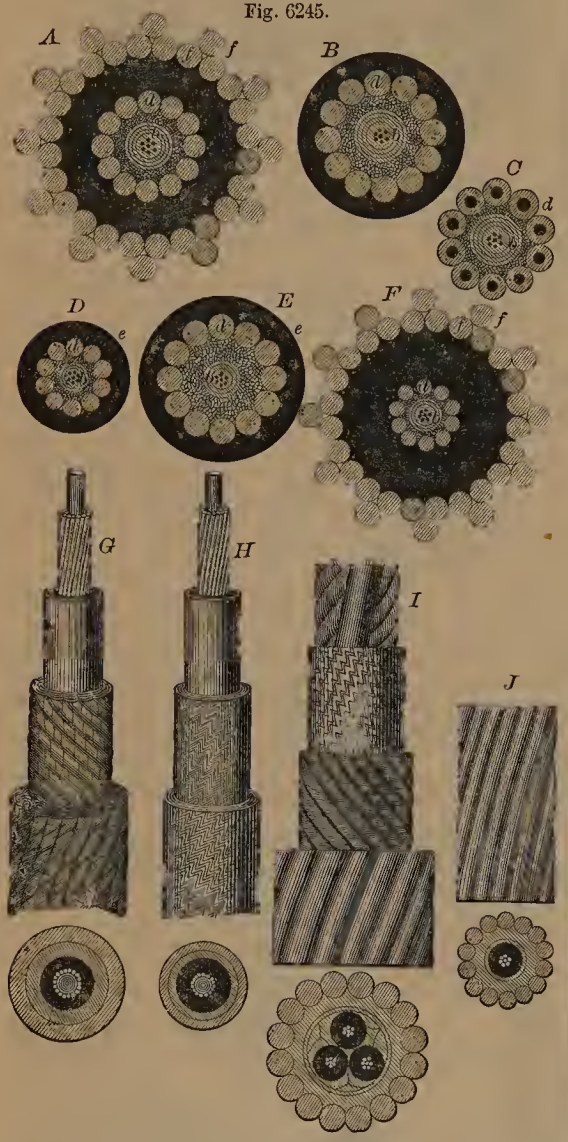
*c d*, the last four cables laid down between Ireland and Newfoundland. The seven wires of the core are each 0.048 of an inch in diameter, that of the whole strand being 0.144 of an inch, weighing 300 pounds to the mile.

The conductor is insulated by four layers of gutta-percha, alternatiug with thin layers of Chattertou's compound, the total diameter of the core being .464 inch. The sheathing consists of ten steel wires, 0.095 inch in diameter, each surrounded by five strands of tarred manilla hemp, and wrapped spirally round a covering of tarred jute yarn which surrounds the core. The weight in air is 4,000 pouuds; iu water, 1,568 pounds to the nautical uile.

*e* is a section on the samc scalc of the shore end of this cable.

The French Atlantic cable was laid by the "Great Eastern" in 1869. It is made in sections varying somewhat in size and mode of manufacture. The illustrations (Fig. 6245) are from "Eugineering," and are one half (linear) the exact size.

Fig. 6245.




*Submarine Telegraph-Cables.*

*A* is a section of the shore ends of the cable between Brest and St. Pierre.

*B*, the intermediatc portion connecting the shore ends to the main portion.

*C*, the main cable of the Brest and St. Pierre section.

*D*, the main cable of the St. Pierre and United States section.

*E*, the intermediate portion of the St. Pierre aud United Statcs section.

*F*, the shore cnd of the said western scction.

The Brest aud St. Pierre section weighs 400 pounds per nautical mile

The western section 107 pounds per nautical mile.

In each case the copper conductor in the ceuter consists of seven wires, six laid arouud one.

In each of them,—

*b* is an insulation of alternate layers of gutta-percha and Chatterton's eompound, covered by a coating of tanued jutc yarn of varying thicknesses in the different figures.

*d*, galvanized homogeneous iron wires bound with manilla hemp steeped in tar.

*e*, Clark's compound, consisting of mineral pitch and silica.

*f*, galvanized iron wire.

*G H I J* illustrate cables made by the Bishop Gutta-Percha Company, of New York.

In *G*, the eenter is an annealed steel wire surrounded by spirally laid copper wires; gutta-percha, $^{9}_{16}$ inch thick, is laid on in three successive coatings; manilla yarn in a short spiral lay; manilla yarn in a long spiral lay. The annealed steel wire weighs 330 pounds per mile; eopper wires, 475; gutta-percha insulation, 475; manilla yarn coating, 750 pounds; total, 2,012 pounds per mile.

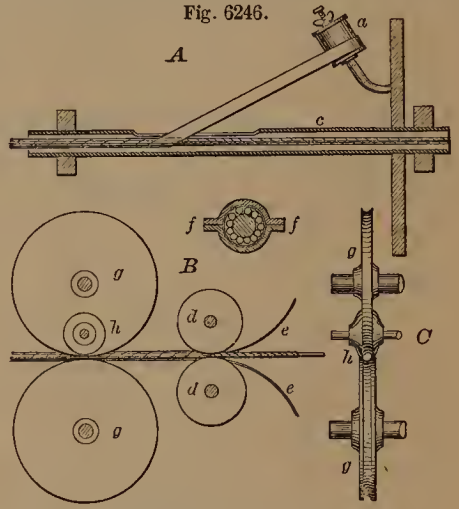
*H* is made in the same manner, except that instead of the manilla yarn two coatings of woven flax banding well saturated with tar are laid on spirally one over the other. Over this are put two coatings of Bishop's patent compound. This cable weighs 1,513 pounds to the mile.

*I* is a three-conductor cable, each strand being composed of nineteen copper wires twisted and insulated by gutta-percha $\frac{3}{8}$ iuch in thickness, covered by woven banding and hemp tarred; the whole is surrounded by 16 No. 3 galvanized iron wires laid on spirally. This cable weighs 15,100 pounds to the mile.

*J*, a single-conductor cable, composed of nineteen copper wires similarly insulated and covered, and protected by 14 No. 7 galvanized iron wires laid on spirally. Its weight per mile is 5,850 pounds.

When rubber is employed for coating cables, an apparatus like that showu in Fig. 6246 is used. The rubber in very thin strips is wound upon a reel *a*, rotatable on a spindle. The

Fig. 6246.




*Telegraph-Cable Apparatus.*

wire is drawn through a slotted tube *c*, the rotation of which winds the strip upon the wire.

A second coating is put on by the apparatus *B C*. Here the wire having received the first coat is drawn by the rollers *d d* between two thin strips of rubber *e e*, the edges of which are compressed together, forming a flange on each side, as shown at *f f*. This is removed by passing it through two grooved rollers *g g*, the lower one of which acts against the two cutting edges of a disk *h*. A third coat is laid on by a similar machine.

A. F. Jaloureau of Paris has patented in the United States a method of forming telegraphic cables by the application of successive layers of bitumen, separated and maintained by spiral bands of bitumenized paper, and consolidated by coils of bitumenized twine or yarn, the whole protected, when necessary, by an outer covering of metallic wire.

In the machine for effecting this (Fig. 6247), the central wire core from the drum *A* is drawn longitudinally through the axis of a wheel carrying two bobbins *G*, by which the interior layer of wrapping-twine is applied, then over a boiler containing heated bitumen, which is applied to the twine by a roller on the longitudinal shaft of the machine; then alternately through the axes of wheels carrying bobbins *D D'*, etc., by which strips of paper are spirally wound on and over troughs of molten bitumen, which is applied by a roller as before.

A final covering of spirally laid twine is applied by bobbins on the wheel *C'*, which is coated with bitumen as the cable passes over another cistern. It is then drawn through a sand-tank *F*, and finally between pressure and tension rollers *G N O*, which extend and compact it. If desired, an outer layer of protecting wires is laid on by an additioual wheel with bobbins similar to that employed in laying on the twine.

For raising a cable, grapnels with four prongs attached to a stout chain twenty or thirty fathoms long, connected to a long rope, are used for finding it and bringing it to the surface in the first instance; the end is then passed through a sheave, and conducted to a drum, rotated by the engine around which it is wound. In shallow waters, underrunning the cable is sometimes resorted to.

The drag-ropc, in comparativcly shallow water, is three or

four times the depth. For the Atlantic cable, the length of rope exceeded the depth by one fifth only.

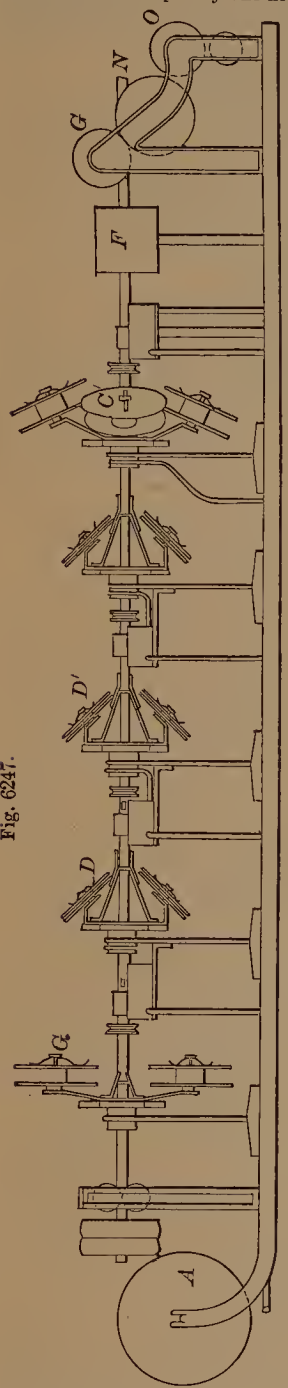



Fig. 6247.

The ship is run several miles to windward of the supposed position of the cable, and the drag being thrown out, she is allowed to drift broadside to, until by the increased strain shown by the dynamometer it is inferred that the cable has been hooked. The cable of 1865 was recovered in 1,900 fathoms of water; at this depth the strain on the dynamometer, due to the weight of the drag-rope, 2,300 fathoms in length, was 7½ tons, increasing at times to 8½ or 9 tons, according to the motion of the vessel; when the steady strain on the dynamometer exceeded this amount, it was assumed that the cable had been hooked; hauling in occupied five or six hours. When at the surface, the tension on the cable was nearly up to its breaking weight. It was grappled ten times, and several times raised a considerable distance, escaping from the grapnel, having been twice brought to the surface before the splicing was effectually accomplished.

*Machine for Manufacturing Telegraphic Cables.*

Fig. 6248 illustrates the manner in which messages are transmitted through the Atlantic telegraph. *a* is the sending-battery; *b b'*, earth-plates; in this case, wires leading into the ocean. The current passes from the battery to the transmitting-lever *c*, and thence through the cable *d* to the point *e* at the receiving-station: here it divides, the greater portion passing through the galvanometer to the condenser *g*, an arrangement of mica plates and tin-foil acting as a Leyden jar. The remainder is conducted through the resistance-coil *h* to the earth-plate *b'*. This continues until the condenser is charged and the galvanometer-needle is no longer deflected. By depressing the lever *c*, its end is brought in contact with the earth-wire; a portion of the electricity stored up in *g* is transmitted back through the cable, taking the galvanometer in its way, and deflecting the needle, which carries a mirror, serving to indicate the letters. See REFLECTING-GALVANOMETER.

The transmission of electricity through a submarine cable is found to be a gradual rather than an instantaneous process. When a signal is made at one end of either of the Atlantic cables, no

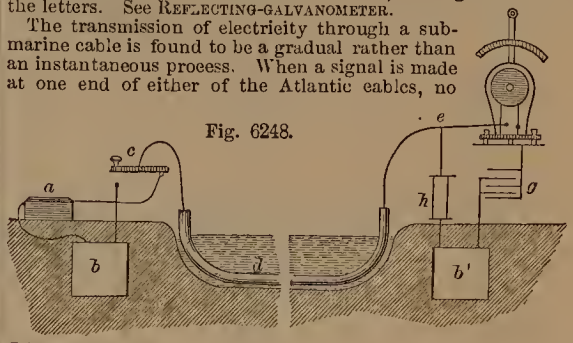



Fig. 6248.

*Diagram to Represent the Working of the Submarine Telegraph.*

effect is experienced at the other for about .2 of a second; after .4 of a second, the current received attains about 7 per cent of its maximum intensity; in one second, about half; and not until the expiration of three seconds does it attain its full strength. To enable the operator at the receiving-station to translate the vibrations thus produced into the letters of the alphabet is the office of Sir William Thomson's REFLECTING-GALVANOMETER (which see).

**Tel'e-graph-car'riage.** A vehicle provided with the apparatus necessary for opening temporary communication with a permanent line. Fig. 6249 illustrates a form of carriage used by the postal department in England. This carries one of each of the different kinds of instruments employed, — six in number, — nearly 150 battery-cells, a proper quantity of telegraph-cable, and has accommodations for eight operators. It is used in military operations, at agricultural shows, races, etc., where no line of telegraph is immediately at hand.

The army-telegraph service is an important feature in most of the large European armies. A *field-telegraph*. See page 839; and notice under TELEGRAPH.

For account of a field-telegraph, see "Popular Science Review," Vol. XIII., London, 1874, pages 141–149.

**Tel'e-graph-clock.** An arrangement by which time is signaled to a number of different apartments in a building or to several buildings.

This may be performed by electro-magnetic devices, or by simply mechanical means. For the former, see ELECTRO-MAGNETIC CLOCK, pages 785, 786.

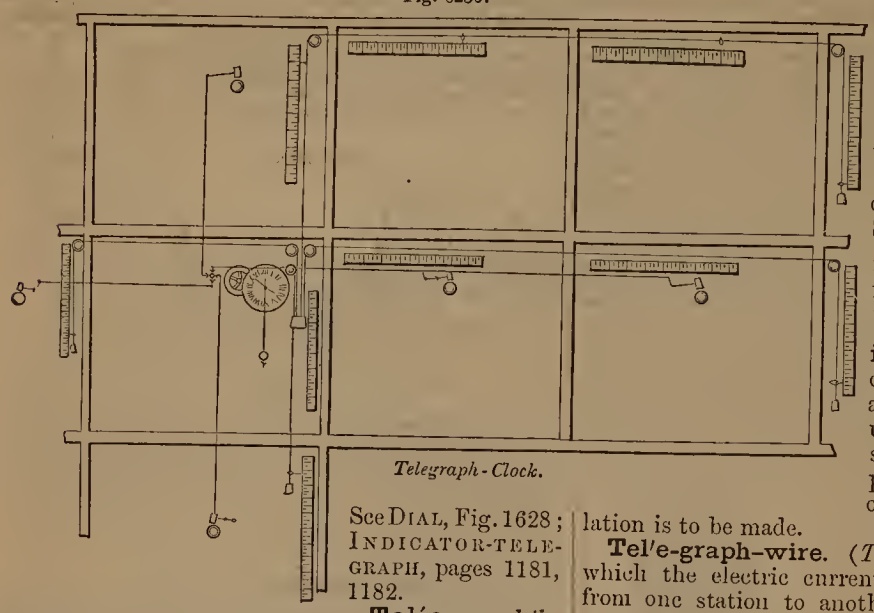
Fig. 6250 is an example of the latter. A traveling pointer in each room moves over an index-path, which is the substitute for a clock-dial, being drawn by a wire connected to a weight, whose descent is controlled by a clock. Another system of wires connects the striking movement of the clock with the bell-hammer in each room, to strike the hours as they occur, in concert with the striking of the principal clock.

**Tel'e-graph-di'al.** A circle on which are arranged the letters of the alphabet, figures, etc., the hand or pointer being operated by electro-magnetic action.

Fig. 6249.

*Telegraph-Carriage.*

Fig. 6250.



*Telegraph-Clock.*

See DIAL, Fig. 1628; INDICATOR-TELEGRAPH, pages 1181, 1182.

**Tel'e-graph'ic Key-board.** The bank of keys of a printing-telegraph machine. See Fig. 3960, page 1802.

**Tel'e-graph'ic Sig'nal.** An alarm or visual indicator, usually set in motion by electro-magnetic means. See TELEGRAPHIC ALARM; SOUNDER.

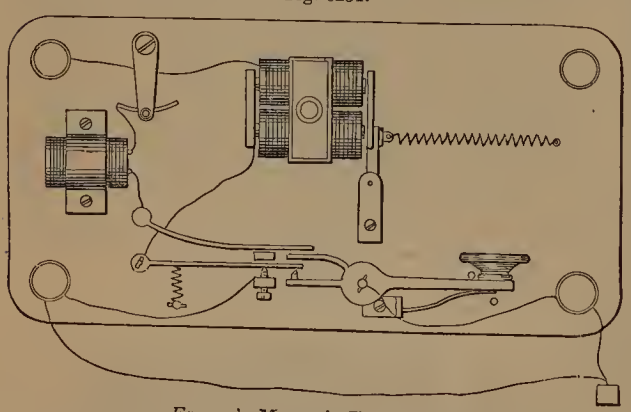
**Tel'e-graph-in'di-cat'or.** A pointer-telegraph. See INDICATOR, Fig. 2669, page 1181.

**Tel'e-graph-in'stru-ment.** A moving mechanical device used in the electric circuit. A *perforator*, *transmitter*, *receiver*, *relay*, *register*, or what not. See list under TELEGRAPH.

**Tel'e-graph-key.** (*Telegraph.*) The vibrating piece in a transmitting-instrument, which is touched by the finger to establish an electric circuit. See MORSE ALPHABET, *b*, Fig. 3225, page 1476.

Fig. 6251 shows a key in connection with Farmer's magnetic telegraph for sending messages simultaneously in opposite directions upon a single line of telegraph. Upon the receiving-mag-

Fig. 6251.



*Farmer's Magnetic Telegraph.*

net is a single set of coils, and the key makes two contacts at the down stroke, closing the branch circuit through the receiving-magnet, and the branch through the rheostat, both at once, and at the same time disconnecting the receiving-magnet from the direct ground, and connecting with the ground through the battery. The rheostat branch circuit is broken at the key at its upward stroke. See also Fig. 2744, page 1225.

**Tel'e-graph-post.** One for keeping the wires elevated above the ground and out of contact with surrounding objects, excepting the insulators on the posts.

**Tel'e-graph-reel.** A device on which the endless slip of paper is wound on a recording-telegraph. A common feature in telegraphs. See *i*, Fig. 3225, page 1476.

**Tel'e-graph-reg'ister.** (*Telegraphy.*) A recording-device at the receiving end of a circuit. See MORSE APPARATUS, Fig. 3225, page 1476; Figs. 4247, 4248, page 1913.

**Tel'e-graph Tar'iff-in'di-cat'or.** A means of ascertaining distance, approximately, by a graduated tape-line or rule sweeping from the central position, representing the office whence the calculation is to be made.

**Tel'e-graph-wire.** (*Telegraphy.*) The road by which the electric current passes from one station to another, the metallic communication between stations, also connecting instruments, battery, and ground. Wire and instruments form the *circuit*.

Wires are attached by *binding-screws* or *terminals* to instruments.

A *loop* is a wire going out of an office and returning to the same and forming part of a main circuit.

*Cross*-wires is a metallic connection between two wires, owing to sagging or a blow. *Weather-cross* is a leakage of current from one wire to another, owing to defective insulation in damp weather.

A *return* wire is a *metallic circuit* used instead of the *earth*

To *disconnect* is to take a wire off, so as to break the circuit, leaving the wire insulated.

To *loop* two wires is to disconnect them from their ordinary places and join them together, so as to form a metallic circuit.

To *cross-connect* wires is to interchange them, so that a current from one wire is shifted to another at one station and then back again at a farther station, to work around a faulty station.

To *put wires straight* is to restore the usual arrangement.

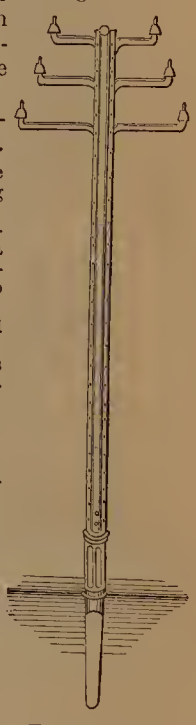
To *ground* a wire, or to *put to earth*, is to make a connection between the line-wire and the earth.

To *open* a wire is to disconnect it, so that no current can pass.

To *shackle* a wire is to cut it and place an insulator between the ends.

Bishop's process for insulating and protecting telegraph-

Fig. 6252.



*Telegraph-Post.*

Fig. 6253.

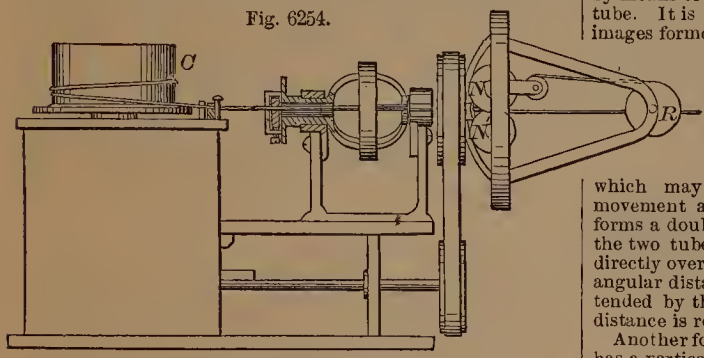
*Telegraph Tariff-Indicator.*

wire cousists in wrapping the wire with a layer of jute, flax, or similar fiber, and applying an exterior coating, composed of asphaltum, 2¼ lbs.; gutta-percha, ¼ lb.; crude rosin, ¼ lb.; spirits of turpentine, ½ gall.; boiled linseed oil, 1 gill; umber, 2 oz. Successive layers of the fiber and compound may be applied.

Moses G. Farmer's telegraph-wire is formed of a core of steel, which is first carefully tinned and then covered with copper, after which the compound wire is tinned, to prevent rusting. See also TELEGRAPH-CABLE.

Fig. 6254 is a machine for covering telegraph-wire with metal. The wire to be covered is drawn along by the rotation of the cylinder *C* to which it is attached, passing through the hollow axle of the overhung wheel *K*, to which uiotion is imparted by belt aud pulley. The metallic covering ribbon is wound upon

Fig. 6254.




*Machine for Covering Telegraph-Wire with Metal.*

the spool *R*, and, being conducted over a small pulley, passes downward to the wire to which it is spirally applied by the two grooved rollers *N N*, connected to the wheel *K*, and revolving therewith. Previous to being wound upon the cyliuder *C*, the compound wire is compelled to pass through a gage.

**Tel'e-i-con'o-graph.** A combination of the telescope and camera-lucida, invented by M. Revoil.

The principle involved is that of allowing the image transmitted by the object-glass of a telescope to pass through a prism connected with the eye-piece. The rays of light that would in the ordinary use of the telescope be transmitted direct to the eye are refracted by the prism, and thrown down upon a table placed below the eye-piece. The distance between the prism and the table determines the size of the image projected on the latter, and it is easy for the observer to trace on a paper placed on this sketching-table the actual outlines indicated by the refracted light. The telescope has both vertical and horizontal motion, and is so constructed that a connected drawing can be made of a larger area than can be included in the object-glass at one view; in fact, an entire panorama can be traced, if the relative positions of the axis of the telescope and the surface of the sketching-table are undisturbed.

**Te-lem'e-ter.** An instrument for determining the distance of an object whose linear dimensions are known, from its apparent length or hight, when viewed between two parallel wires of a telescope.

A graduated rod has long been used for this purpose in surveyiug; the number of divisions included between the two wires showing at once the distance in yards, feet, or other units between the rod and the telescopes.

In instruments of this kind used iu military operations for ascertaining the distance of troops, the two wires are made to approach or recede from each other; standard distances, the hights of infantry and cavalry, are assumed as bases to which an indicating scale upon the telescope is graduated.

Bardou's (Fig. 6255) consists of a telescope whose eye-tube *a* is surrounded by a broad flange *b* marked with a scale *c* for showing the distance in yards of infantry. An exterior ring *f* is gradnated for showing the distance in yards of cavalry. By means of interior teeth *b'* on the flange *b* engaging pinions *c c* on the screw-pins *d d'*, two wires are caused to approach or recede from each other; when these exactly coincide with the extremities of the object, the uumber beneath the iudex *o*, upon the scales *b*, indicates the distance if infantry be observed, or upon *f* if the object be cavalry. *g g'* are the field-lenses, and *h* is the object-glass.

Rochon's double-image telescope has within its tube a prism of Iceland spar (a mineral possessiug the power of double refraction), which divides the pencil of rays into two pencils diverging from each other at a determinate angle. This prism is, by means of a rack and pinion, movable from end to end of the tube. It is moved back or forth until the edges of the two images formed by the prism are in exact contact, when an index ou the slide indicates the distance according to a scale engraved on the outer surface of the tube.

The binocular marine-glass of M. Lorieux, of Paris, is designed to determine distances by the angle subtended by an object of known dimensions. It comprises two telescopes, the axes of which may be thrown out of parallelism by an angular movement around an axis joining the two eye-pieces. This forms a double image of the object, which appears single when the two tubes are parallel. One of these images will appear directly over the other; and when their edges are in contact, the angular distance between the two tubes is equal to that subtended by the object at the eye of the observer, whence the distance is readily inferred.

Another form of telemetric marine-glass by the same optician has a vertical plate on each side of the axis of the object-glass of the telescope. These are made to approach to or recede from each other by means of a right-handed screw on one side, and a left-handed screw on the other, the distance of the object being inferred from the distance apart of the two plates when their edges exactly coincide with the extremities of the object. In later constructions of this instrument, the edges of the plates are placed horizontally, as being generally more convenient.

The prism-telemeter consists of two prisms connected by a measuring-chain or tape-line, serving as a base for the triangle which determines the distance. The two observers face each other. The difference in the apparent direction of the object, as viewed by reflection in the prisms, indicates by a scale attached thereto the distance of the object.

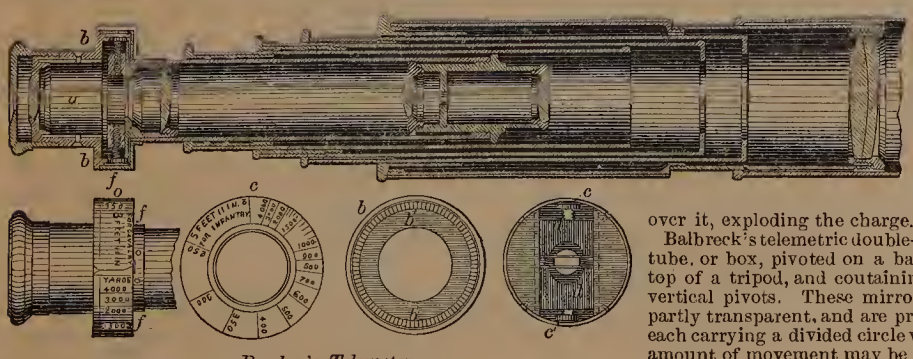
The telemetrical telescope of Captain Gautier, of the French artillery, indicates the distance of an object by the angles formed by it at two different stations successively. The object is viewed by reflection from a prism which causes a known deviation, 3°, in its apparent direction, and from two opposite mirrors, all in the tube of the instrument.

An electric telemeter for ascertaining the distances of objects in motion has been invented by Captain Kocziczka, of the Austrian engineer corps.

Two points of observation at a known distance apart are connected by a telegraph-wire. At each station is a telescope, parallel to the axis of which, and turning with it, is a long thin needle. A second needle turns on a point representing the other station, and is connected with the wire therefrom. When an object is observed simultaneously at each station, the angle formed by the two needles — one following the motion of its own telescope, and the other that of the telescope at the other station, with which it is electrically connected — fixes the position of the object on a plat of the country placed on the table on which the instrument is mounted.

An instrument analogous to this was devised by the Archduke Leopold, to determine the proper time to explode a torpedo when an enemy's vessel passes over it. If a series of torpedoes be arranged in a straight line, one station is placed on the prolongation of this line, while the other commands a cross view of it. When a vessel passes over this line, the observer at the first station touches a key, which closes a circuit passing through both stations. The second observer, having his telescope, which is provided with a metallic arm that touches successively a series of terminals communicating with the conductors, will, at the same moment, by the movement of the telescope, bring this arm in contact with the insulated wire belonging to a torpedo, if the vessel passes directly over it, exploding the charge.

Fig. 6255.




*Bardou's Telemeter.*

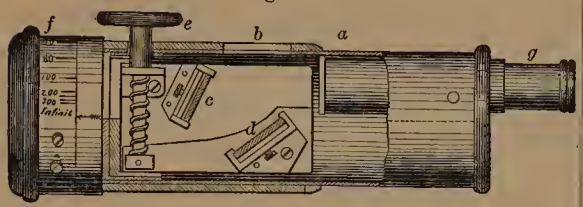
Balbreck's telemetric double-telescope consists of a square tube, or box, pivoted on a ball and socket joined at the top of a tripod, and containing two mirrors turning on vertical pivots. These mirrors are partly silvered and partly transparent, and are provided with tangent screws, each carrying a divided circle with an iudex, by which the amount of movement may be read. Two telescopes enter

the tube at right angles from opposite directions; one at each end just beyond the mirrors. A rectangular glass prism is placed at the focus in the angle to change the direction of the rays. The distance between the centers of the mirrors is one metre. Openings are made in the sides of the box opposite the mirrors to admit light from the object to be observed.

In observing, the box is turned until the object seen by reflection is brought into coincidence with the central line of the telescope at the other end. Through the transparent part of this mirror the object will be seen by reflection, but not on the central line. It is brought into coincidence with this by means of the tangent screw. The box is now revolved 180°, and the object viewed through the other telescope, and adjustments made similar to those first described, the box being turned as before, bringing the second image again to coincide with the first. The divided circle of the first mirror will then show very nearly the true parallax; a correction is, however, necessary if very accurate results are desired.

The telemeter of Captain Gautier, of the French army (Fig. 6256), consists of a tube *a*, having an opening *b* at one side, and containing two mirrors set normally at an angle of 45°, one of

Fig. 6256.




*Gautier's Telemeter.*

which (*c*) is fixed, and the other (*d*) admits of slight movement by means of a thumb-screw *e*. A ring *f* turning on the axis of the instrument carries a prism, through which an object may be viewed by direct vision.

In measuring distances, the observer selects a distant and well-defined object nearly at right angles to that whose distance is to be determined, and having brought the zero or "infinity" line on the ring opposite an arrow-mark on the tube, he views the first object or "natural signal" by direct vision through the eye-tube *g*, looking over both the mirrors and through the prism. By turning the screw *e*, the image of the object whose distance is sought, and the rays from which, passing through the opening *b*, are reflected from *c* to *d*, and thence to the eye, is brought into coincidence with the natural signal. He then steps back a certain distance, say 20 yards, on the prolongation of the line passing through this first station and the natural signal. This distance, which serves as a base line, should not be less than $\frac{1}{100}$ of that of the station from the object whose distance is sought. The reflected image will no longer coincide with the "natural signal" seen by direct vision through the prism. By turning the ring *f* the prism is revolved until its refraction again causes the two images to coincide. The ring is provided with a graduated scale containing a series of factors by which the length of the base must be multiplied in order to obtain the distance of the object. That factor which stands opposite the arrow on the tube is the proper multiplier.

These factors are derived by a simple calculation, from the trigonometrical properties of a triangle supposed to be right-angled at the second station. Should the first and second stations, however, not be precisely in line with the natural signal, a correction may be applied, depending on the amount of this angular variation; but this correction is so small, within the limits of angular measurement, as to be neglected in ordinary practice.

The ring may, on the same principle, by assuming one or more invariable base-lines, be so graduated as to give the distance directly in yards or metres. See also Wilson's United States patent, September 29, 1868, No. 82,669.

**Tel'e-phone.** An instrument for conveying signals by sound. It may consist of a steam-whistle, a fog-trumpet, or other audible alarm. The term, until lately, has been particularly applied to a signal adapted for nautical or railroad use, in which a body of compressed air is released from a narrow orifice and divided upon a sharp edge, in the manner of a steam-whistle.

The term is now acquiring a different signification.

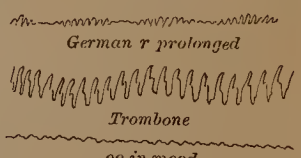
The subject of the number of vibrations per second, as constituting a given note, has been considered under MUSIC, PITCH, PIPE, etc.; and the mode of counting the vibrations under SIREN. The *vibroscope* is another instrument invented by Duhamel for the same purpose. See also METRONOME; TONOMETER.

Articulate sounds are accompanied by the expulsion of air from the mouth, which impulses vary in quantity, pressure, and in the degree of suddenness with which they commence and terminate.

An instrument which will record these impulses has been termed by its inventor, Léon Scott, a *phonautograph*, or *phonograph*, and by Mr. Barlow a *logograph;* the pressure of the air in speaking is directed against a membrane which vibrates and carries with it a delicate marker, which traces a line on a traveling ribbon. The excursions of the tracer are great or small from the base line, which represents the quiet membrane, according to the force of the impulse; and are prolonged according to the duration of the pressure, different articulate sounds varying greatly in their length as well as in intensity; farther, another great difference in them consists in the relative abruptness of the rising and falling inflections, which make curves of various shapes, of even or irregular shape. The smoothness or ruggedness of a sound has thus its own graphic character, independent both of its actual intensity and its length.

Barlow's *logograph*, described in the London "Popular Science Review," Vol XIII. page 278, *et seq.*, consists of a small speaking-trumpet, having an ordinary mouth-piece connected to a tube, the other end of which is widened out and covered with a thin membrane of gold-beater's skin or gutta-percha. A spring presses slightly against the membrane, and has a light arm of aluminium, which carries the marker, consisting of a small sable brush inserted in a glass tube containing a colored liquid. An endless strip of paper is caused to traverse beneath the pencil, and is marked with an irregular curved line, the elevations and depressions of which correspond to the force, duration, and other characteristics of the vocal impulse. The lines thus traced exhibit remarkable uniformity when the same phrases are successively pronounced.

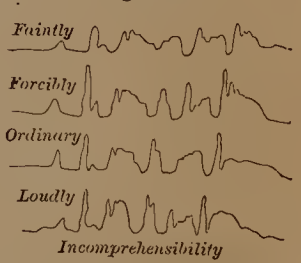
Fig. 6257.




*Lines obtained by the Phonautograph.*

Fig. 6257 shows curves obtained by Mr. Charles A. Morey by the interposition of a light lever between the membrane and the smoked glass, which is drawn along beneath the style, whose excursions are much magnified by the lever. The curves show respectively the tongue trill or German *r* prolonged, the mark produced by the sound of a trombone, and by the sound of *oo* in mood. See "American Journal of Science and Arts," August, 1874, pages 130. 131.

Fig. 6258.




*Logographic Curves.*

Fig. 6258 shows a tracing from the utterance of the word "incomprehensibility," with different degrees of effort. It will be noticed that while a certain variation occurs due to the energy, each sound preserves a specific character.

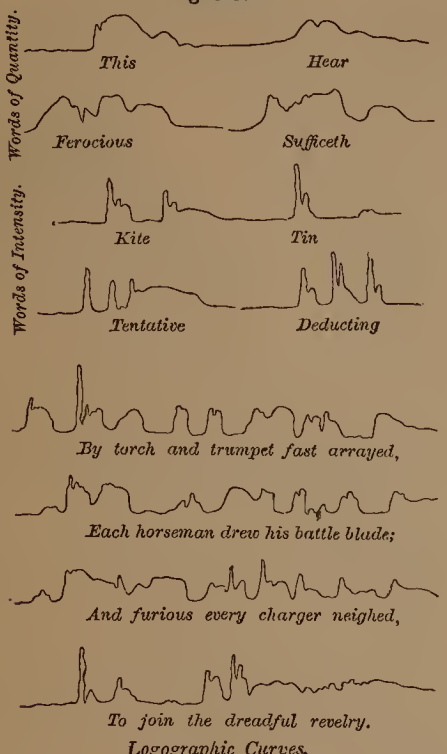
Fig. 6259 shows in the upper portion the effect of words of quantity which require a large volume of air, and are maintained a relatively longer time than the more explosive or intense kind.

The lower diagram is what the tracer wrote when the familiar stanza from "Hohenlinden" was repeated.

A much more delicate instrument for obtaining sonorous vibrations has been made by Professor A. Graham Bell and Clarence J. Blake, M. D., of Boston, Mass. (June, 1874), by using the *membrana tympani* of the human ear as a phonautograph. Dr. Blake's mode of exposing the middle ear without injuring the ossiculæ or the delicate tympanic membrane is described at length in the "Boston Medical and Surgical Journal," February 4, 1875, pages 121–123.

The *stapes* was removed, and a short style of hay substituted of about the same weight, so as to increase the amplitude of the vibrations and afford means of obtaining tracings upon smoked glass, as in the phonautograph experiments. The membrane is kept moist by a mixture of glycerine and water, and the speci-

Fig. 6259.

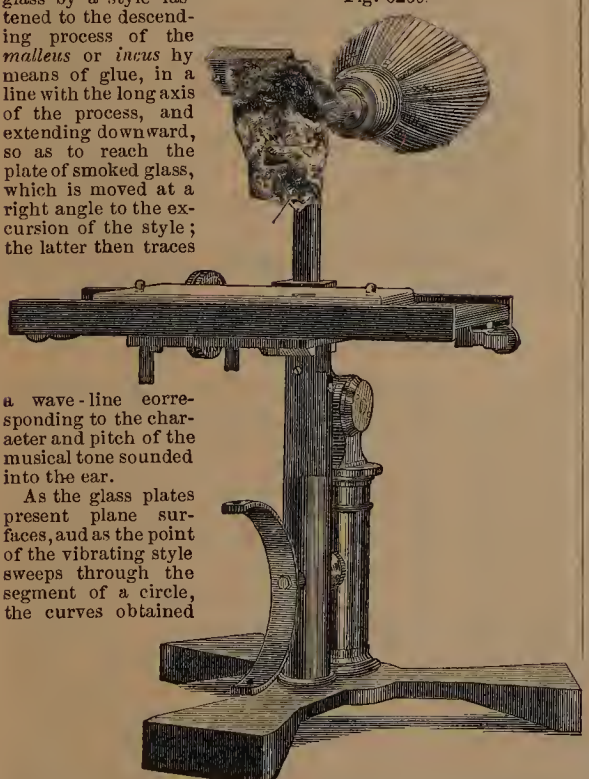



*Logographic Curves.*

men attached to a perpendicular bar sliding in an upright post, and moved by a ratchet-wheel. To the upright is attached, horizontally, a metallic stage six inches in length, upon which slides a carriage with a glass plate, and having a regular movement given to it by wheel and cord. A bell-shaped mouthpiece is inserted in the external auditory meatus and luted in position.

The vibrations of the membrane due to a musical tone sounded in the bell may be observed by means of a ray of light thrown upon small specula of foil attached to the *malleus*, *incus*, or to different portions of the *membrana tympani*, or may be recorded on smoked glass by a style fastened to the descending process of the *malleus* or *incus* by means of glue, in a line with the long axis of the process, and extending downward, so as to reach the plate of smoked glass, which is moved at a right angle to the excursion of the style; the latter then traces a wave-line corresponding to the character and pitch of the musical tone sounded into the ear.

Fig. 6260.



As the glass plates present plane surfaces, and as the point of the vibrating style sweeps through the segment of a circle, the curves obtained

*The Membrane of the Tympanum used as a Phonautograph.*

are apt to be discontinuous, especially when the amplitude is great. To obviate this difficulty, a sheet of glass is employed having a *curved* surface, the concavity being presented to the style. The sheet of glass is a section of a cylinder whose semi-diameter is equivalent to the length of the style. In this way the point of the style never leaves the surface of the glass, and the curve resulting from its vibration is continuous. The carbon film is preserved by pouring collodion upon it; as soon as this is dry, the film may be floated off with water and placed upon a plane sheet of glass, or upon paper, and varnished in the ordinary way.

See the following works: "Use of the Membrana Tympani as a Phonautograph and Logograph, with Plates," Archive for Ophthalmology and Otology, 1876. "Use of the Membrana Tympani as a Phonautograph and Logograph," Boston Med. and Surg. Journal, Feb., 1875. "Mechanical Value of the Distribution of Weight in the Ossicula," Trans. Am. Otological Society, 1874.

Another step in the direction of the conveyance of sound consists in connecting a membrane in a mouth-trumpet by means of a fine cord with a similar membrane in a trumpet applied to the ear of a person at a considerable distance, say in another room. The sounds are audible, not merely as to pitch, but are recognizable as articulate sounds. The writer knew an officer who was with Nelson at Copenhagen, who was wounded so that his hearing was destroyed. He was in the habit of placing a music-box against his teeth, or holding in his teeth a string whose other end was shut tightly between the lid and the box. He said he *heard* very well.

The experiment of connecting distant sounding-boards, so that one is made to vibrate in unison with the other, is familiar; indeed, the synchronous vibration may be obtained even by the vibrations of the atmosphere, as when the sounds of a piano are repeated by those of a guitar which has been tuned in unison and stood up in the corner of the room. This is even more palpable when the guitar is laid upon the piano top.

"There is an experiment, first made by Wheatstone, where the music of a piano is transferred from its sound-board, through a thin wooden rod, across several silent rooms in succession, and poured out at a distance from the instrument. The strings of the piano vibrate, not singly, but ten at a time. Every string subdivides, yielding not one note, but a dozen. All these vibrations and subvibrations are crowded together into a bit of deal not more than a quarter of a square inch in cross section. Yet no note is lost. Each vibration asserts its individual rights; and all are, at last, shaken forth into the air by a second sound-board, against which the distant end of the rod presses. Thought ends in amazement when it seeks to realize the motions of that rod as the music flows through it." —Prof. Tyndall, in "Martineau and Materialism."

From the mechanical transmission of sounds by the air, string, or wooden rod, we pass by a decided step to devices by which vibrations are made to produce rapid contacts and breaks of an electric circuit, and thus become means of transmitting tones; and, conversely, to means of making rapid contacts, so as to set matter vibrating, and causing it to generate musical tones.

The knowledge that the pitch of tone depended upon the rapidity of vibration was well known to Pythagoras; the generation of sound by motion is familiar in the vibration of strings and wires in the Æolian harp, and the sound of the wind in a tube. The tuning-fork is so proportioned that it produces sounds of but one *pitch*, while its *timbre* depends on the quality of its material, and its *intensity* upon the amplitude of its vibrations.

Besides the tone generated by the agitation of the atmosphere, it was observed as long ago as 1785, by the Canon Gottoin de Coma, that an iron wire of at least 10 yards in length, when stretched in the open air, spontaneously gives forth a sound under the influence of certain variations in the state of the atmosphere, the effect being due to the transmission of atmospheric electricity. This transmission does not in fact occur in a continuous manner like that of a current, but rather by a series of discharges.

Mr. Beatson has proved that the discharge of a Leyden jar through an iron wire causes this wire to produce a sound if the discharge is first passed through a moist conductor, such as a wet string or animal tissue.

Professor Page in America, De la Rive in France, Gassiot in London, and Marrian in Birmingham, discovered that rods of iron placed in the interior of a helix through which a current of electricity is passed give out decided sounds at the moment when the circuit is made or broken.

Reis applied this discovery in his telephone. By causing the circuit to be made and broken very rapidly, a musical note was emitted by a rod placed in a helix traversed by the current.

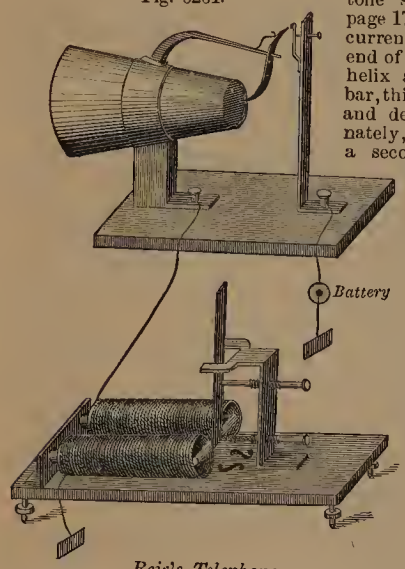
De la Rive found that exactly similar sounds were produced where the intermittent current was passed through the iron rod itself; and Professor Bell has produced similar effects by passing the current through retort carbon, plumbago, German-silver wire, and platinum wire.

In fact, the intermittent current occasions a molecular vibra-

tion in the conductor through which it is passed, whatever may be the material of which it is made, and this vibration may be rendered audible by coiling up the conducting-wire and applying it to the ear; as, for instance, an empty helix of copper wire, through which a discontinuous current is passed.

In the electro-magnetic telephone of Kirpath, the telephone sending-instrument consists of an open funnel in which the tone is sounded, and a diaphragm of thin elastic membrane, which is set in vibration by the tone, and which by its vibrations continually makes and breaks the electric circuit. The number of breaks in a second corresponds with the number of vibrations belonging to the tone sounded (see PIPE, page 1708); and since the current passes at the other end of the line through a helix around a soft iron bar, this bar is magnetized and demagnetized, alternately, as many times in a second as there are vibrations in the tone sounded at the sending-instrument At each demagnetization, a longitudinal shrinkage of the bar occurs, and a resulting sound; this is rendered more audible by placing the bar on a delicate sounding-board, which partakes of the vibrations synchronously with those of the original membrane, and reproduces the same sound.

Fig. 6261.

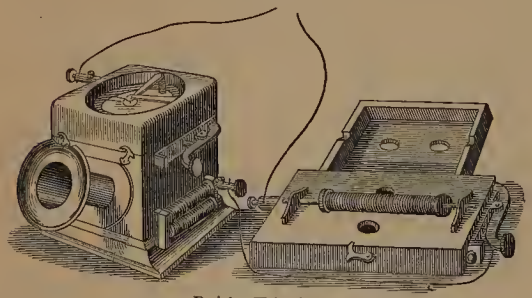



*Reis's Telephone.*

Fig. 6261 shows one of Reis's telephones, used by Legat in his experiments upon *Telephonie*. The discontinuous current, produced by the oscillating lever which vibrates in concert with the membrane on the end of the trumpet, is passed through an electro-magnet (shown beneath), so as to occasion vibration in its armature, which is attached to a sounding-board.

Fig. 6262 principally differs from the other in its receiving-instrument. The intermittent current traverses a coil surrounding a rod of iron, occasioning a molecular vibration in the iron. The resulting sound is rendered more intense by placing the rod and helix upon a sounding-board.

Fig. 6262.



*Reis's Telephone.*

Another form of receiving-instrument is thus described by De la Rive: —

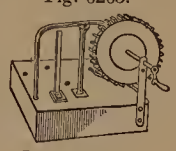
"The most brilliant sound is that which is obtained by stretching upon a sounding-board well-annealed wires, $^1/_{20}$ or $^2/_{20}$ of an inch in diameter and from 3 to 6 feet in length. They are placed in the axis of one or several bobbins, the wires of which are traversed by electric currents, and they produce an assemblage of sounds, the effect of which is surprising, and which greatly resembles that to which several church-bells give rise when vibrating harmonically in the distance"

De la Rive mentions one or two *rheotomes* or *circuit-breakers*, forms of apparatus employed by him in his experiments upon the production of sound telegraphically, for the purpose of making and breaking the circuit very rapidly.

Fig. 6263 is simply a toothed wheel so arranged as to make and break contact with a spring resting against the edge. By giving the wheel a movement upon its axis, we cause the plate to leap from one tooth to another; each leap produces a rupture in the circuit, which is closed again immediately afterward. The musical tone given out by the plate, when we have no other means of measuring it, gives us exactly the number of times that the circuit has been opened and closed, that is to say, interrupted, in a second.

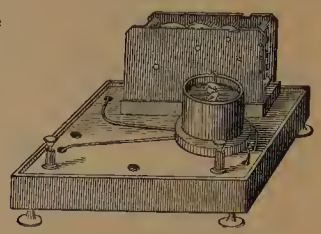
Fig. 6264 is another form of rheotome used by De la Rive, consisting of four needles arranged upon a horizontal rod, so as to dip into mercury alternately when the axis is caused to revolve.

Fig. 6263.



*De la Rive's Rheotome.*

Fig. 6264.



*De la Rive's Circuit-Breaker or Rheotome.*

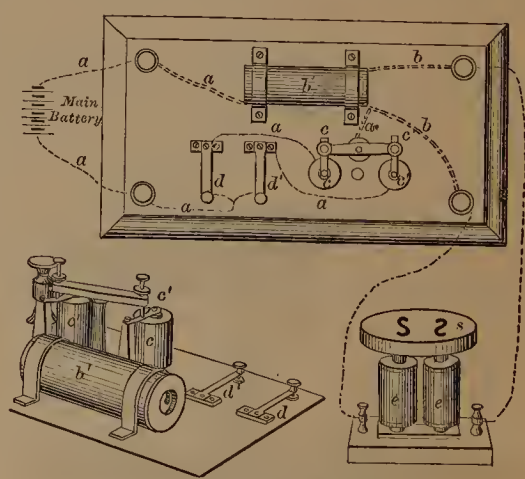
The two needles are inserted perpendicularly and parallel with each other, and so arranged that when they are immersed simultaneously in two capsules filled with mercury, and insulated from each other, the circuit is closed; and when they are not immersed, it is open. A clock-work movement, or simply a winch moved by the hand, gives a rotatory movement to the axis; whence it follows that in a given time — a second, for example — the circuit may be closed or interrupted a great number of times.

Attention has long since been directed to the utilization for telegraphic purposes of the means afforded and effects elicited by the numerous observers and experimenters in this branch of acoustics.

It is well known that many distinct sounds pass through the air simultaneously without interference, and that the ear is capable of receiving several impressions at the same time, or is capable of directing its attention to one set alone, as when one listens to an alto alone of a quartette, oblivious at the time of the other voices, though not perhaps of the words of a friend seated by one's side.

Gray's electro-harmonic telegraph is founded upon the principle before stated, that an electro-magnet elongates under the action of the electric current, and contracts again when the current ceases. Consequently, a succession of impulses or interruptions will cause the magnet to vibrate, and if these vibrations be of sufficient frequency a musical tone will be produced, the pitch of which will depend upon the rapidity of the vibrations.

Fig. 6265.




*Gray's Electro-Harmonic Telegraph.*

By interrupting an electric current at the transmitting end of a line with sufficient frequency to produce a musical tone by an instrument vibrated by said interruptions, and transmitting the impulses thus induced to an electro-magnet at the receiving end of the line, the latter will vibrate synchronously with the transmitting-instrument, and thus produce a musical tone or note of a corresponding pitch.

The instrument shown in Fig. 6265 consists of the transmitting-apparatus mounted on a base-board, and a receiving-apparatus, shown in a position beneath the former. The induction-coil $b^1$ has the usual primary and secondary circuits. An ordinary automatic electrotome *c* has a circuit-closing spring $c'$ so adjusted as when in action to produce a given musical tone. A common telegraph-key *d* is placed in the primary circuit *a a* to make or break the battery connection. The key being depressed, and the electrotome consequently vibrated, the interruptions of the current will simultaneously produce in the

secondary circuit *b b* of the induction-coil a series of induced currents or impulses corresponding in number with the vibrations of the electrotome; and as the receiving electro-magnet *e* is connected with this circuit, it will be caused to vibrate by successive elongations and contractions, thus producing a tone of corresponding pitch, the sound of which may be intensified by the use of a hollow cylinder *s* of metal, placed on the poles of the magnet.

When a single electrotome *c* is thrown into action, its corresponding tone will be reproduced on the sounder by the magnet. When electrotomes *c c'* of different pitch are successively operated by their respective keys *d d'*, their tones will be correspondingly reproduced by the receiver; and when two or more electrotones are simultaneously sounded, the tone of each will still be reproduced without confusion on the sounder, so that by these means melodies or tunes may be transmitted.

Another system is founded upon the alternate making and breaking of a telegraphic circuit by means of the vibration of tuning-forks or musical reeds, as in Helmholtz's apparatus for the production and transmission of vocal sounds. If a given fork be made to interrupt an electric circuit by its vibrations, and the intermittent current thus produced be passed through a series of electro-magnets, each in connection with a fork of different pitch, and consequently different rate of vibration, only that fork will be thrown into vibration which is in unison with the first one. Practically the time required to do this is a small fraction of a second. The advantages of this method are numerous. Not only may many receiving instruments at one station be operated, each by its own key, through a single wire, but many different stations in the same circuit may be operated, that one alone receiving the message which has an instrument with the requisite pitch, so as to vibrate in synchronism. Many signals may in this way be transmitted over the same wire at the same time, and many dispatches sent simultaneously to as many stations. All this may be done, too, without affecting the line for its ordinary use.

Three inventors have been and are working at this form of apparatus, — Elisha Gray and A. G. Bell of the United States, and La Cour of Denmark. See English patents Nos. 1,740 and 2,646 of 1874; 947 and 974 of 1874. La Cour, 2,999 of 1874. Gray's United States patents, 166,094, 166,095, 166,096, of 1875; 175,971 of 1876. Bell's patents, 161,739 of 1875; 174,465 of 1876.

In Gray's electric telegraph for transmitting musical tones, the transmitting apparatus consists of a keyboard having a number of electro-magnets corresponding with the number of keys on the board, to which are attached vibrating tongues or reeds, tuned to a musical scale. Any one of these tongues can be separately set in motion by depressing the key corresponding to it.

The closing of either of the keys completes the primary circuit from the battery through the electrotome connected with the key depressed, and the circuit-closing spring of said electrotome will immediately be thrown into rapid vibration, and a musical tone of a certain pitch will be given forth, while at each vibration the current in the primary circuit of the induction apparatus will be interrupted. By the usual intermediate means secondary induced currents are transmitted to the receiving station. Thus, for example, if the circuit-breaking spring of the electrotome vibrates one hundred and twenty-eight times per second, the tone given forth is that known as the *fundamental C*, while one hundred and twenty-eight terminal secondary currents will be induced in the secondary circuit of the induction apparatus, and transmitted through the animal tissue, — which may be the human body, — forming part of said circuit, to the resonant receiver, and will, from some cause not understood or explicable in the present stage of the art, vibrate the same synchronously with the transmitting electrotome, and thus give forth a musical tone of the same pitch.

This animal membrane must possess the specific characteristics of being a conductor of electricity; of being yielding and elastic; and of having a surface of greater electric resisting capacity than its interior.

These characteristics are found in the skin of the human body, as shown in Fig. 6268.

The operation of the key and its corresponding electrotome may be more readily understood by referring to Fig. 6266. In this, *a* is a steel reed tuned to vibrate at a definite rate corresponding to its position in the scale. One end is rigidly fixed to the post *b*, while the other end is left free, and is actuated by a local battery. The magnets *e* and *f* are arranged in the same local circuit, magnet *f* having a resistance of about thirty *ohms*, and magnet *e* about four *ohms*. When the reed *a* is not in vibration, the point *c* is in electrical contact with it, which throws a shunt-wire entirely around the magnet *f*; thus, practically, the whole of the local current passes through magnet *e* at the instant of closing the key *c*. It is well known that when two electro-magnets are placed in the same circuit, the one which has the higher resistance (other things being equal) will develop the stronger magnetism, and that if the magnet of higher resistance be taken out of the circuit, the force of the other will be increased. When the key *c*, being depressed, closes the local circuit at *d*, the operation of the reed is as follows: The whole of the current from battery *l* passes through the magnet *e*, which attracts the reed say with a power of four. When the reed has moved toward *i* far enough to leave the point *g*, the shunt circuit is broken, and the current flows through both the magnets. Immediately, the power in *f* rises from zero to five, and that of *e* drops from four to one, and the reed is attracted toward *f* with an effective force of four, until contact is again established with the point *g*. The operation is repeated at a rate determined by the size and length of the reed which corresponds with the fundamental of the note it represents.

Fig. 6266.

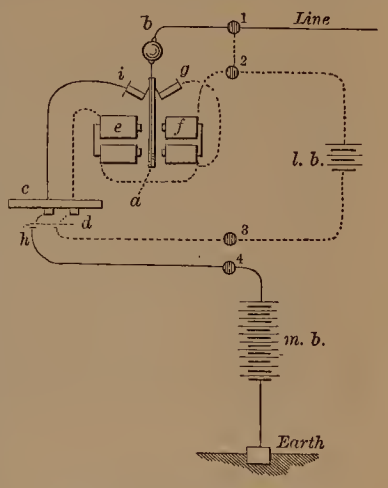



*Diagram of Gray's Telephonic Transmitter and Circuits.*

The main battery is connected as follows: One pole is connected to the ground; the other runs to the instrument, and, entering at binding-screw 4, runs to point *h* of key *c*; from key *c* to point *i*, which makes contact with the reed *a*; from reed *a* to binding-screw 1, and thence to line. It will be seen that when the key is at rest the batteries are open at the points *d* and *h*.

The diagram, Fig. 6266, shows but one key and connections, but all the keys in the instrument, whether one or more octaves, have corresponding reeds and actuating-magnets, the only difference being in the tuning of the reeds. There is but one main and one local battery used, and the connections to each key are run in branch circuits from the binding-screws, as shown in Fig. 6266. But since all these branches are open at the key-points, neither of the batteries is closed unless a key is depressed.

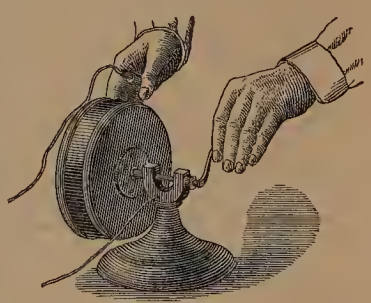
If now the keys are manipulated, a tune may be played which is audible to the player. When any key is depressed, the local battery sets in vibration its corresponding reed, which sounds its own fundamental note according to the law of acoustics. So far, the instrument is an electrical organ with steel tongues, the motive power being electricity instead of air. The main battery has had no part whatever in its operation.

Fig. 6267.

*Gray's Telephonic Transmitter, for Composite Tones.*

If, however, the main circuit is closed by connecting the distant end to ground, and the point *i* is properly adjusted so that it makes and breaks contact with the reed at each vibration, a series of electrical impulses, or waves, will be sent through the line, corresponding in number per second to the fundamental of the reed, and corresponding synchronous electrical waves can be converted into audible vibrations at the distant end of the line, the note produced being of the same pitch as that of the sending reed.

Fig. 6268.



*Gray's Telephonic Receiver.*

There are various ways by which these electrical waves may be converted into audible material vibrations. One of them, shown in Fig. 6268, is a thin cylindrical sounding-box, made of wood, the face of which is covered with a cap made of thin metal, electrically connected to the metal stand by means of a wire.

If the operator connects the cap, through the stand, to the ground, and, taking hold of the end of the line with one hand, presses his fingers against the cap, which he revolves by means

of the crank with the other hand, the tune that is heing played at the other end of the line hecomes distinctly audihle, the intensity of the sound heing determined by the rate of revolution of the plate. When the motion stops, the sound entirely ceases.

The animal tissue plays a prominent part, as previously stated. If, instead of the revolving plate and the animal tissue, an electro-magnet be placed in the circuit, or a number of them, and a tune he played at the transmitting end, the tune will he heard from all these receiving electro-magnets. These may be on the principle of that shown in Fig. 6265, consisting of a eommon electro-maguet having a bar of iron rigidly fixed at one pole, which extends across the other pole, but does not touch it by about $\frac{1}{64}$ of an inch. In the middle of this armature a short post is fastened, and the whole mounted on a box made of thin pine, with openings for acoustic effects.

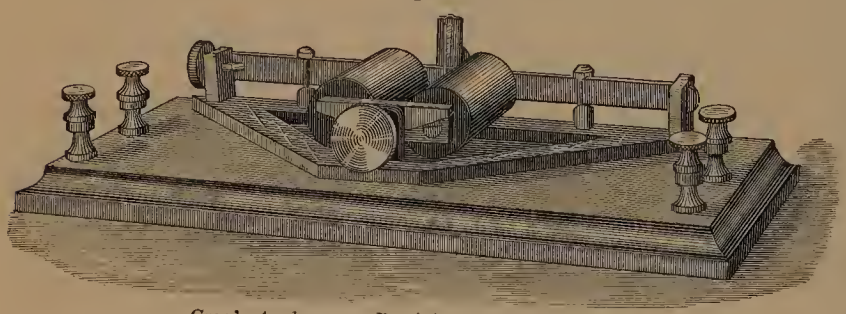
So far, consideration has been given to simple tones, but, as in the case of the string and rod referred to previously, a single wire has been found adequatc to convey composite tones; a considerahle number of tones of different pitch, either in harmony or discord, and the metallic plate or hattery of magnets is adequate to translate them. In adapting this principle to a rapid telegraphic system, it hecomes necessary to analyze the tones at the receiving end, so that the various messages in the different tones from as many transmitters worked by distiuct operators, and all sent to line without any regard to each other, may be sorted at the receiving end by a corresponding number of receiving instruments, each of which shall sound its appropriate message in its own tone, ignoring all the others. The messages, say eight in number, and of as many varying tones, having heen simultaneously sent to line, may he said — for the convenience of statement — to he carried as a composite tone to the receiving end, where they pass through a series of receivers, each one of which is in harmony with one of the transmitters. Each receiver sorts out its own message, and among them they may be said to ahsorh the whole of the vast number of complicated vihrations which have heen sent pell-mell through the wire in the form of so many successive magnetizations and demagnetizations.

Fig. 6269 is a perspective view of one form of a receiving instrument called an *analyzer*. It consists of an electro magnet adapted to the resistauce of the circuit where it is intended to be used, and of a steel ribhon strung in front of this magnet in a solid metal frame, and provided with a tuning-screw at one end, so as to readily give it the proper tension. The length and size of the ribbon depend upon the tone required. If this ribhon he tuned so that it will give a certain note when made to vihrate mechanically, and the note which corresponds to its fundameutal is then trausmitted through its magnet, it will respond and vibrate in unison with its transmitted note; hut if another note he sent which varies at all from its fundamental, it will not respond. If a composite tone is sent, the ribhon will respond when its own note is heing sent as a part of the composite tone, but as soon as its own toue is left out it will immediately stop. Thus it *analyzes* the tones which are passing over the line, and selects its own, allowing the others to pass to other instruments with which they are in accord.

A successful experiment with this system was made at Milwaukee, Wis., on January 8, 1876. A loop was arranged by way of Horicon to Portage and hack hy way of Watertown, a distance of 200 miles. Over this siugle wire eight operators sent messages and signals in the same direction at the same time, without any one interfering with another. See for fuller description "Journal of the American Electrical Society," Vol. I. 1875. See also Gray's patent, No. 175,971, dated April 11, 1876.

The same principle has been applied to the transmitting and receiving apparatus of sounding, recording, and printing telegraphs. Bell's patcnt, No. 161,739, April 6, 1875, comprises a transmitter consisting of a local circuit containing an electro-magnet, with a steel spring armature tuned to a pitch corresponding with a similar armature $b$ in the receiver $a$, and vihrating hetween two platinum points, one communicating with the main line, and the other with the local. The impulses are produced by a key $k$, and are transmitted through the main line to the receiving magnet $a$, the spring armature $b$ of which tilts a light, pivoted, non-conducting lever, having at its other end a platinum how $g$ that dips into two cups of mercury and closes the circuit. The wooden lever $f$ is balanced so as to vihrate much more slowly than the spring armature by which it is operated, and does not resume its normal position in contact with the latter until this has ceased to vihrate; that is, until the key $k$ has been raised.

Fig. 6269.

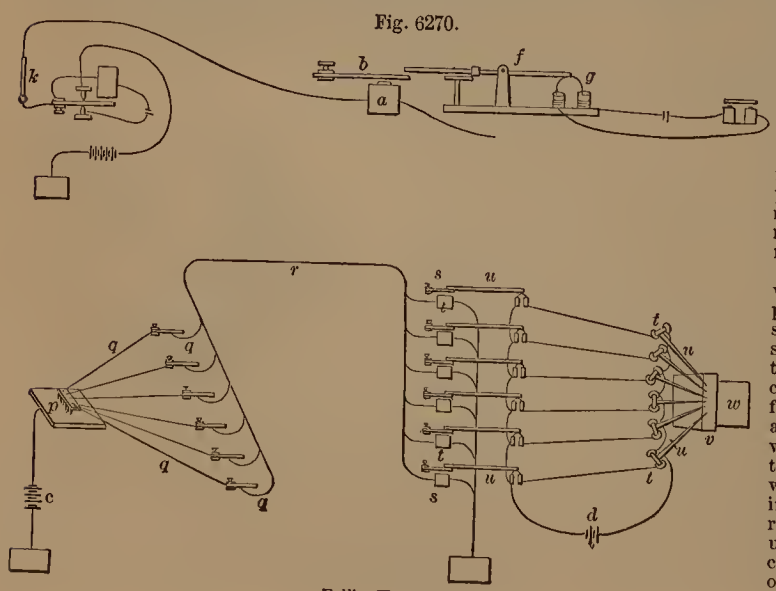


*Gray's Analyzer, or Receiving-Instrument.*

An autographic telegraph on this principle is composed of a numher of these transmitters, the armature of each heing connected by a wire with a metallic or conducting bristle mounted in a non-conducting base placed over a metallic plate $p$, with which the bristles are in contact.

The plate is in communication with the main battery $c$. The bristles are insulated from each other, and are placed as near together as possible. From the platinum point with which each transmitter comes in contact in making the circuit, wires $q$ $q$ lead to the line wire $r$. At the other end of the line is a series of receiving-instruments $s$ $s$ corresponding in number to and having armatures vibrating in consonance with those of the transmitters. Branch wires connect the receivers with the main line wire $r$. In connection with each receiver is a local circuit comprisiug an electro-magnet $t$ and a vihratory lever $u$, one arm of which coustitutes the armature of the magnet, and the other arm terminates in a stylus which normally rests upon an ink-ribhon $v$ over the bed of the receiving-table $w$. The stylus-armed ends of the levers converge, so as to be in the same relative positiou, and about as near together as the metallic bristles at the transmitting end of the line. The message to he copied at the receiving end of the line is written or impressed with non-metallic ink on a sheet of metallic foil, and this sheet is placed ou the metal plate under the bristles at the transmitting end.

Fig. 6270.




*Bell's Transmitter.*

The sheet of paper or other material on which the message is to be delivered is placed on the receiving-tahle $u$, under the stylus-armed levers, and both sheets are simultaneously drawn over their respective tahles. So long as the bristles have metallic contact, intermittent electrical impulses from their respective transmitters pass along the line wire and operate the receivers, whose armatures $s$ $s$ are attracted, and dip into the mercurial cups, which are in a circuit worked by the battery $d$, lifting the recording ends of the levers away from the ink-ribhon. When, however, the writing comes under the bristles, each, as the metallic contact is interrupted by the interposition of the non-metallic ink, ceases to transmit the electrical impulses, and the circuit-

breaker of the corresponding receiver is raised out of contact with the mercury, the stylus end of the lever comes in contact with the ink-ribbon and causes a mark to be impressed upon the paper underneath. Springs may be employed to give this downward impulse to the levers when the circuit is thus broken. The effect of the alternate elevation and depression of the levers actiug upon the ink-ribbon is to reproduce ou the receiving-sheet a fac-siuule of the writing or object drawn upon the metallic foil at the transmitting end.

Bell's patent, No 174,465, March 7, 1876, describes a method of operating telephonic apparatus by means of uudulatory currents of electricity. Instead of making and breaking the circuit, he throws it into waves. He distinguishes three kinds of vibratory curreuts by which telephonic effects may be produced. 1. *Intermittent;* by making and breaking the circuit. 2. *Pulsatory;* by occasioning *sudden* chauges in the intensity of a coutinuous current. 3. *Undulatory;* by causing *gradual* changes in the iutensity of a continuous current. The specification describes the effect upon the current of transmitting a nnmber of musical notes simultaneously by intermittent or pulsatory impulses, and by undulatory currents respectively, and also instances several modes of throwing the current into waves either with or without a battery.

**Tel'e-scope.** An instrument for magnifying distant objects, so as to make them appear comparatively near.

Gerbert of Auvergne, who taught astronomy in his school at Rheims, observed the stars through a tube, A. D. 1000 He derived it from his tutors at Cordova, and they, no doubt, from the Alexandrian savans. In both places, celestial observatious were made through long tubes with object and ocular diopters at the respective ends. No lenses as yet.

Who was the first discoverer of the telescope cannot now be determined. Spectacles were known in the thirteenth century. Roger Bacon employs some expressions indicative of a knowledge of the effect of the combination of lenses. Dr. Dee mentions (1570) that "perspective-glasses" will enable a commander to ascertain the strength of an enemy's forces, referring apparently to an optical instrument then in use.

Baptista Porta said: "If you properly combine a concave and a convex lens, you will see distant and near objects larger and clearer."

Digges states that by an arrangement of mirrors and transpareut glasses the image of a small object at a distance may be so augmented as to be brought apparently near to the observer. The matter is restated in a second edition of his works, published in 1591.

Toward the middle of the seventeenth century, Borelli, a Dutch mathematician, interested himself in determining the questiou of inventorship, and decided in favor of Jansen and Lippersheim, spectacle-makers of Middelburg, Hollaud, about 1590. Galileo, hearing of the principle of the new wonder, constructed one in 1609, magnifying four times, a second magnifying seven times, and then one magnifying thirty-two times.

It is only fair to give another account, for which we are indebted to Descartes, who lived at about the time when the invention was made public, and had a right to know whereof he affirmed. He says it was made by James Metius, and was due to a fortunate accident. James was a glass-cutter, and had a brother who was a professor of mathematics and a maker of mirrors and burning-glasscs. James, it appears, was amusing himself by trying the effect of looking through two glasses, held in line and at a distance, by the respective hands. Fortunately he tried the experiment with a concave and convex glass, which gave the wonderful effect now so familiar. They were fitted in a wooden tube, and made the first telescope ever used in the world, says Descartes. The inventor was a suspicious character, and tried to keep the invention secret even on his deathbed. But his brother and some few others had seen it, and were able to follow the track, which they opened to the world, and which was followed by Galileo. Humboldt says: —

"The accidental discovery of the space-penetrating power of the telescope was first made in Holland, probably as early as the close of the year 1608. According to the latest documentary investigations, this great invention may be claimed by Hans Lippershey (or Laprey), a native of Wesel, and spectacle-maker at Middelburg; Jacob Adriansz, also called Metius, who is said to have made burning-glasses of ice; and Zacharias Jansen.

"Lippershey, on the 2d of Octobcr, 1608, offered to the States-General 'three instruments with which one can see to a distance.' On the 17th of the same month, Metius, in his offer to the States-General, states that 'through meditation and industry he had constructed such instruments for two years.' Zacharias Jansen, who, like Lippershey, was a spectacle maker at Middelburg, togêther with his father, Hans Jansen, invented the compound microscope having a concave lens for its eye-glass, toward the end of the sixteenth centurv (probably about 1590), but discovered the telescopc only in 1610.

"When the news of the recent Dutch invention reached Venice, Galilco was accidentally present; he at once divined what were the essential conditions of the construction, and immediately completed a telescope at Padua for his own use He directed it first to the mountains of the moon, and showed the method of measuring their hights; attributing, like Leonardo da Vinci and Möstlin, the ashy-colored light of the moon to the light of the sun reflected back upon her from the earth. He examined with small magnifyiug powers the group of the Pleiades, the cluster of stars in Cancer, the Milky Way, and the group of stars in the head of Orion. Then followed in quick succession the great discoveries of the four satellites of Jupiter, the two 'handles' of Saturn, — or his surroundiug ring imperfectly seen, so that its true character was not at first recognized, — the solar spots, and the crescent form of Venus.

"As early as November, 1610, Galileo wrote to Kepler that 'Saturn consists of three heaveuly bodies in contact with each other.' In this observation there was the germ of the discovery of Saturn's ring. Hevelius described, in 1656, the variations in the form of Saturn, the unequal opening of the 'handles,' and their occasional entire disappearance. But the merit of having explained scientifically all the phenomena of the ring of Saturn taken as one belongs to Huyghens (1655). Dominic Cassini first saw the black stripes in the ring (1684), and recognized its division into at least two concentric rings.

"The spots on the sun were first observed through telescopes by John Fabricius of East Friesland, and by Galileo either at Padua or Venice. Fabricius published his discovery in June, 1611, while Galileo did not make his generally known until May, 1612. Galileo noticed that the same spots sometimes returned, and was persuaded that they belonged to the sun itself. The difference in their dimensions when near the center of the sun's disk and on approaching his margin attracted his attention; though it does not appear, from his second letter to Welser, in August, 1612, that he had observed the inequality of the ashy-colored border at the two sides of the black nucleus, when approaching the limb of the sun. Fabricius, like Galileo, recognized the fact that the spots belonged to the sun itself, and also noticed that spots which he had observed disappeared and returned again, and these phenomena taught him the rotation of the sun, which had been conjectured by Kepler before the discovery of the spots. The cycle of admirable discoverics, which scarcely occupied two years, was completed by the observation of the phases of Venus. As early as 1610, Galileo noticed the sickle or crescent form of the planet, and, according to a practice much in vogue in those days, concealed the important discovery in an anagram.

"Huyghens, with an object-glass polished by himself, first discovered one of Saturn's satellites (the sixth) in March, 1655; and from a superstitious notion, entertained by some astronomers of the period, that the number of satellites could not exceed that of the primary planets, did not seek to discover any more of them. Four other of Saturn's moons were discovered by Dominic Cassini; the seventh, or outermost, which has great alternations of brightness, in 1671, the fifth in 1672, and the third and fourth in 1684, with an object-glass of Campani's having a focal length of 100 - 136 feet. The two innermost, or the first and second, were discovered in 1788 and 1789 by Herschel, with his colossal reflector. The second satellite offers the remarkable phenomenon of performing its revolution arouud the principal planet in less than one of our days.

"The telescopes which Galileo constructed himself, and others which he used for observing Jupiter's satellites, the phases of Venus, and the solar spots, magnified four, seven, and thirty-two times in linear dimensions, — never more.

"The 'Arenarius' of Archimedes says very distinctly that 'Aristarchus had confuted the astronomers who imagined the earth to be immovable in the center of the universe; that this center was occupied by the sun, which was immovable, like the other stars, while the earth revolved around it.'"

Turning the invention to immediate account, Galileo discovered the spots on the sun. On January 7, 1610, he discovered three of the moons of Jupiter, and the fourth shortly after. His discovery of the phases of Venus furnished another proof of the truth of the heliocentric theory. The papal persecution which followed Bruno, who was burnt in 1600, and Galileo, who was denounced in 1616, are familiar to readers. Galileo was visited by Milton while in prison, became blind, then deaf, and died a prisoner of the Inquisition, which followed him after death, denied his right to make a will, to be buried in consecrated ground, or to have a monument. The nineteenth century has attended to the latter duty.

The eye-glasses of the Galilean telescope were double-concave. Kepler first pointed out the possibility of making telescopes with two convex lenses. Scheiner, in 1650, reduced it to practice. De Rheita made one with three lenses; he also made a binocular telescope. The focal length of some of these telescopes was immense. Campani, in 1672, made one for Louis XIV., the focal length of whose object-lens was 136 feet. Auzont had one of 600 feet. Huyghens had one of 123 feet, which is still preserved by the Royal Society of London.

These were used without tubes. Huyghens adopted the plan of placing his object-glass in a short tube, having a ball-and-socket joint, at the top of a tall pole. To this tube was connected a string, so that the observer could bring its axis in line with that of another short tube containing the eye-glass. The great difficulty of managing these cumbrous instruments led to the invention of the reflecting-telescope.

The difficulty of the problem is thus stated by Whewell, in his "History of the Inductive Sciences": —

"If we endeavor to augment the optical power of this instrument, we run, according to the path we take, into various inconveniences, — distortion, confusion, want of light, or colored

images. Distortion and confusion are produced if we increase the magnifying power, retaining the length and the aperture of the object-glass. If we diminish the aperture, we suffer from loss of light. What remains, then, is to increase the focal length."

"Comes Mr. Reeve with a twelve-foot glasse. Up to the top of the house, and then we endeavoured to see the moon, and Saturn, and Jupiter, but the heavens proved cloudy."—PEPYS'S *Diary*, 1668.

"The May-pole which stood close to the site of the church of St. Mary-le-strand was begged in 1717 by Sir Isaac Newton, and removed to Wanstead, where it was used in raising the largest telescope then known."—PENNANT'S *London*.

Telescopes are of two kinds, reflecting (or catoptric) and refracting (or dioptric). In the former, an image of the object to be viewed is produced by a concave reflector; in the latter, by a converging lens.

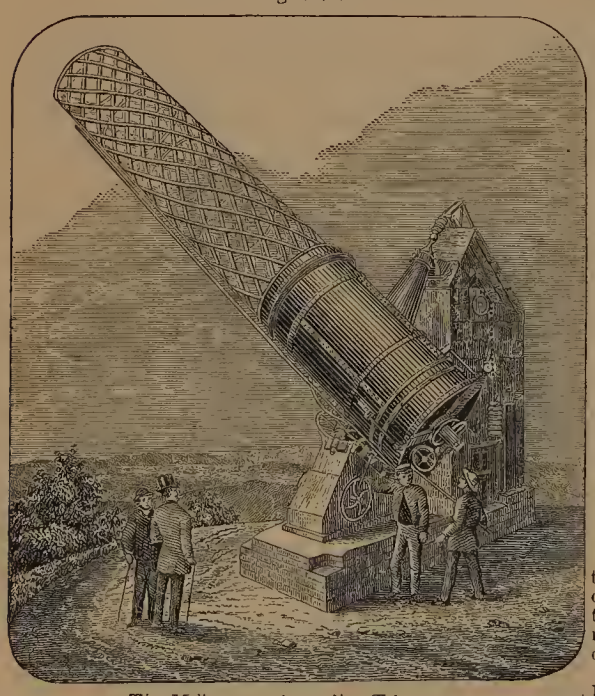
Reflecting telescopes are of four kinds.

The Gregorian telescope (*A*, Fig. 6272) was invented by James Gregory of Aberdeen in 1663. It has an annular metallic speculum and a smaller concave speculum placed in the axis of the tube, at a distance from the larger speculum greater than its focal length. The eye-piece is placed in a smaller tube at the extremity of the longer tube.

The Cassegrainian telescope (*B*, Fig. 6272), was invented by Cassegrain in 1672. It is similar to the Gregorian, except that the smaller speculum is convex instead of concave, and that it is placed in the tube at a distance from the larger speculum less than its focal length. A telescope of this kind, having a speculum of 4 feet diameter and 30 feet 6 inches focal length, was sent from England to Melbourne in 1868. The speculum weighed 3,500 pounds, and was composed of 32 parts copper and 14.77 tin.

Fig 6271 is a representation of the Melbourne telescope, which is really a very fine instrument. The tube is of open work, in order to avoid the air-currents, which with such powerful and delicate instruments are sometimes very annoying in large closed tubes. The mirror in this telescope is placed at the bottom of the tube, and a hole is pierced in the center, in which is placed the *ocular*, in this respect like the Gregorian and Cassegrainian. The hole does not make any practical difference in

Fig. 6271.

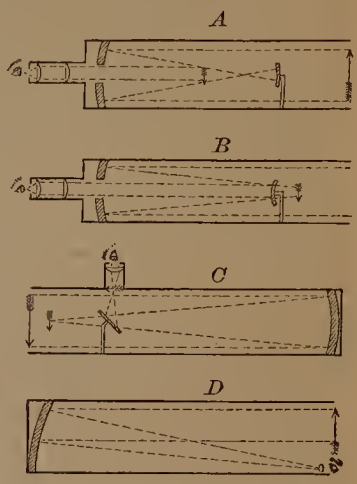


*The Melbourne, Australia, Telescope.*

the working of the mirror. The clock-work for driving the instrument is seen attached to it The astronomer directs his *ocular* to a little plane mirror at the upper part of the tube, where the star image is reflected from the parabola.

The Newtonian telescope (*C*, Fig. 6272) was invented by Sir Isaac Newton in 1669. A large concave reflector is placed at one end of the tube. At a distance from the larger mirror less than its focal length is placed, at an angle of 45° to the optic axis of the telescope, a plane reflector, by which the rays proceeding from the object are turned to the side of the tube and viewed by an eye-piece whose axis is at right angles to the axis of the large tube. Foucault used a prism, which was an improvement, especially in making solar observations.

Fig. 6272.




*Reflecting-Telescopes.*

Fig. 6273 represents the reflecting-telescope made by Sir Isaac Newton's own hands, and presented to the Royal Society, in whose possession it remains.

Fig. 6274 is the new reflecting-telescope in the national observatory of Paris. It has a parabolic glass mirror, weighing 1,300 pounds, at the bottom of the tube, from which the rays are reflected to a plane mirror in the head of the telescope, the image there formed being examined through a system of magnifying-glasses known as the *ocular*. The telescope is suspended on a movable axis, and has all the usual adjustments in altitude and azimuth with the automatic clock-work motion.

The platform on which the observer stands travels on the rails shown on the floor, and is omitted from the engraving. The weight of the movable portion of the telescope is 9 tons; its cost, $40,000.

In the Gregorian, Cassegrainian, and Newtonian instruments the central rays are lost. In the telescope (*D*, Fig. 6272) of Sir William Herschel, invented in the latter part of the last century, the large speculum is inclined to the axis of the tube, and

Fig. 6273.

*Telescope of Sir Isaac Newton.*

the image of the object observed is brought to the interior edge of the tube, where it is examined by the eye-piece instead of through the medium of the second reflector. By this instrument Sir William Herschel made his numerous and important discoveries.

Herschel's 7, 10, and 20 foot reflectors were made about 1779. He discovered Uranus, March 21, 1781. In 1789, he completed his 40-foot telescope, which was taken down in 1822.

The largest instrument of this class ever made was erected by Lord Rosse on his estate at Parsonstown, Ireland, in 1842.

The diameter of the speculum is 6 feet, having a reflecting surface of 4,071 square inches,—more than double that of Herschel's 40-foot telescope, with which he discovered the moons of Saturn and Uranus, and which had a polished surface of but 1,811 square inches.

A foundry was constructed for the special purpose of casting the speculum, which is composed of copper and tin combined in very nearly their atomic proportions, or 126.4 copper to 58.9 parts tin.

The metal was molten in cast-iron crucibles 2 feet in diame-

ter and 2½ feet deep; these were allowed to heat ten hours previous to the introduction of the metal, which required ten more hours to acquire sufficient fluidity for pouring. The bottom of the mold was formed of layers of hoop-iron turned to the required shape, and its sides of sand. When sufficiently cooled, the cast was removed to the annealing-oven, where it was allowed to remain for sixteen weeks previous to undergoing the grinding process. This was effected under water, by means of a cast-iron grinder having grooves cut lengthwise, transversely, and circularly in its face, emery being used to abrade the surface of the speculum and wear it to a truly circular form; this operation required six weeks.

The tube of this huge telescope, including the speculum-box, is 56 feet long, and is made of 1-inch deal boards hooped with iron. On the inside, at distances of 8 feet, are also iron rings 3 inches deep and 1 inch broad, for strengthening the sides. The diameter of the tube is 7 feet, and it is fixed to masonry in the ground by a universal joint, to allow it free movement in any required direction. At 12 feet distance on each side, walls are built 72 feet long and 56 feet high at their highest parts, the walls being 24 feet distant from each other, and lying exactly in the direction of the meridian. These allow the telescope a motion of but about 15 degrees on either side of the meridian, in an east and west direction; but in the opposite direction, that of the meridian, it may be lowered until nearly parallel with the horizon, when directed south, and so as to point to the north pole of the heavens in the other direction. Elevation or depression is effected by means of a chain and windlass, and the telescope being counterpoised in every direction, two men can perform these operations with great facility, though the total weight is about 15 tons, the speculum alone weighing 3 tons. The total cost of the instrument was not less than £12,000.

Specula for reflecting-telescopes are now made of silvered glass. Its use was first suggested by M. Foucault. Dr. Henry Draper of New York has been very successful in constructing specula of this kind; his process is described in the fourteenth volume of the "Smithsonian Contributions to Knowledge."

M. Secretan of Paris has constructed one for the observatory of Marseilles exceeding 2½ feet in diameter.

The advantages possessed by glass are that it weighs but from one half to one third as much as speculum metal, that it can be made much thinner, it is more easily wrought, and the loss of light by reflection from the silvered surface is comparatively trifling, while that from a metallic mirror amounts to from one third to one half; besides, should the silvering become tarnished, it can be removed by solution, and replaced without the necessity of regrinding the speculum.

The following remarks on the *apertures* and *powers* of telescopes, by Mr. Tomlinson, will be interesting:—

"The largest achromatic telescopes, such as those at Dorpat and Kensington, have each a clear opening of 13 inches, while that of Lord Rosse's reflector is 6 feet. Taking the diameter of the pupil of the eye at ⅛ inch, the former instruments admit 10,816 times and the latter 331,776 times the quantity of light which is received from any object by the unassisted eye. But as every speculum absorbs about half the light that it receives, the latter number must be reduced to 165,888. These numbers, then, show how much the area of any object may be magnified by these telescopes without rendering it less bright than it appears to be to the naked eye; and their square roots, 104 and 407, show their magnifying powers in such a case.

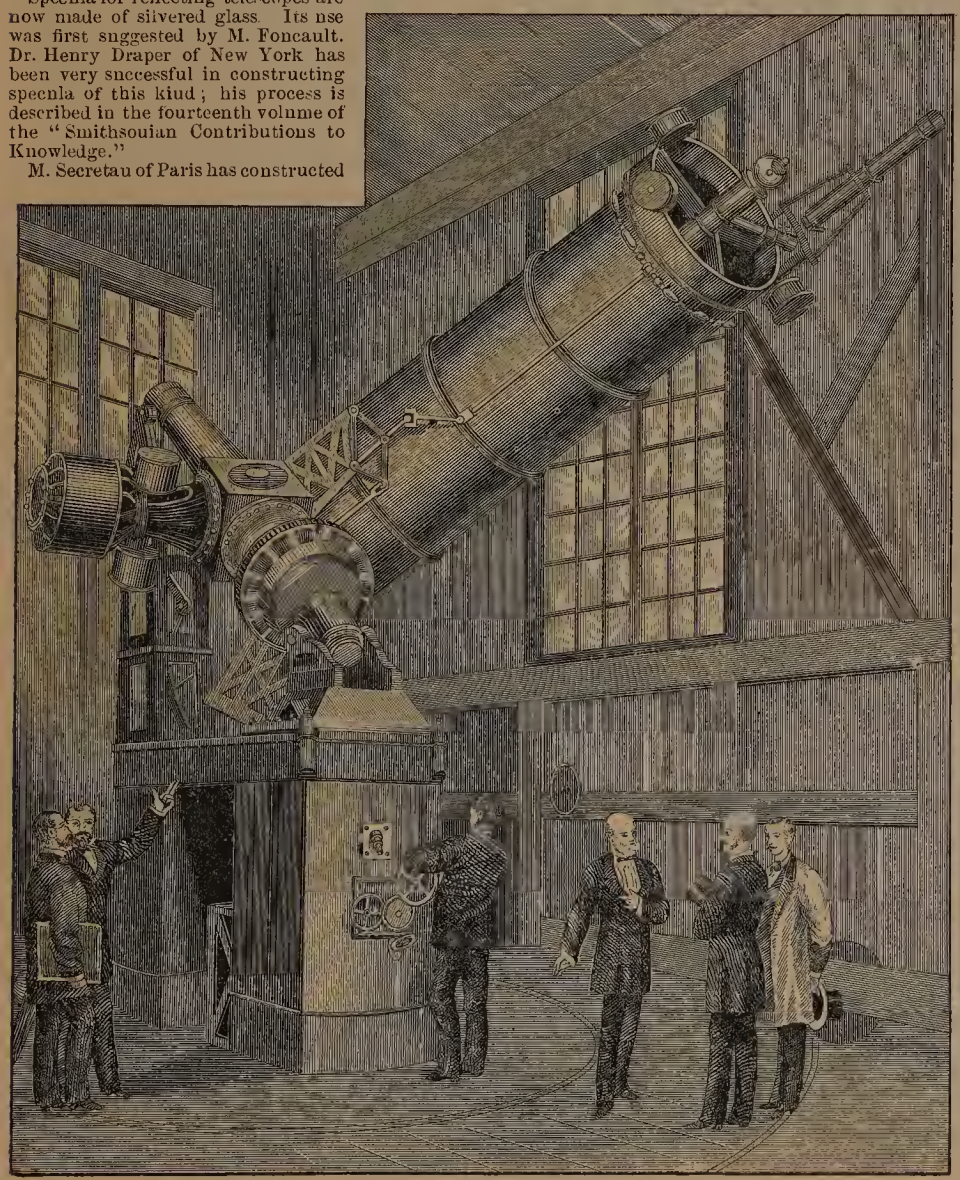
"We may also, from the size of the aperture of any other telescope, estimate what is called its absolute or penetrating power, which is independent of its length or internal arrangements, and depends solely on the size of the object-glass. The number obtained by the above rule shows how many times farther any object may be seen with the telescope than without it, supposing its brightness to remain the same at all distances as it does *in vacuo*.

"The *magnifying power* is totally independent of this, and can be made as great as we please, however small the telescope; but it is obvious that as long as the quantity of light admitted is the same, the more the image is enlarged the fainter it will be, its brightness being always proportional to the quotient of the absolute power divided by the magnifying power. If the latter exceed the former, as it does in astronomical telescopes, the object will be less bright than to the naked eye; but if the absolute exceed the magnifying power, the object will be seen brighter with the telescope than without it."

The telescope at the Washington Observatory, having double the aperture of either of the refractors referred to above, of course admits four times the quantity of light. In this respect it is, however, surpassed in a nearly fourfold ratio by the great reflector of Lord Rosse.

A refracting-telescope in its simplest form consists merely of a double convex lens (the object-glass), which forms an image of the object to be viewed, and a second and smaller double convex lens, called the

Fig. 6274.



*Great Reflecting-Telescope of Paris.*

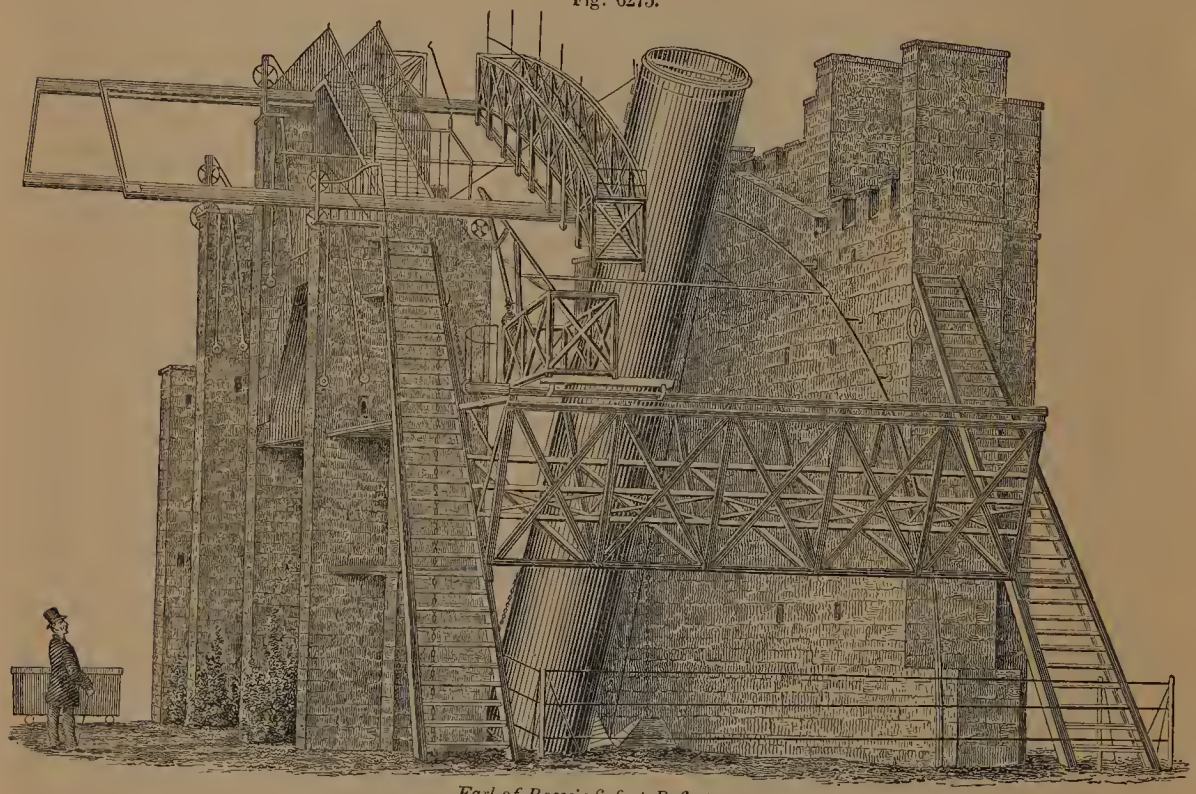
eye-piece, used as a simple microscope to examine the object formed by the first. For perfection of result, the object-glass is made double or triple, to neutralize certain optical inconveniences, called spherical and chromatic aberration, and the eye-glass is generally composed of two lenses suitably combined.

The telescope of Galileo (*A*, Fig. 6276) has a double convex object-glass and a double concave eye-glass. The common opera-glass is made on this principle. The eye-pieces of telescopes are the Ramsden, or *positive*, and the Huyghen, or *negative*.

The positive (*B*, Fig. 6276) has two plano-convex lenses, with the convex sides toward each other. The inner one is the field-glass, and the outer the eye-glass. Their focal lengths are equal. It is suited for micrometers and other instruments having wires in the focus of the object-glass.

The negative eye-piece (*C*, Fig. 6276) has two plano-concave lenses, the convex sides of both being turned toward the object-glass. The ratio of the focal lengths is usually 3 to 1, the

Fig. 6275.

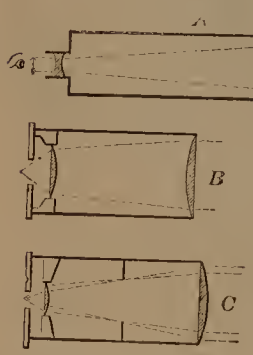


*Earl of Rosse's 6-foot Reflector.*

latter representing the eye-glass. — G. CHAMBERS. See LENS; ACHROMATIC LENS.

The equatorial telescope is so mounted that its vertical axis points toward the pole, having an inclination corresponding to the latitude, so that a single motion, one of rotation around that inclined axis, will cause the line of sight, the optical axis, to trace upon the sphere a circle corresponding to that in which any heavenly body appears to move. The circles increase or diminish as the telescope is moved upon its horizontal pivot, changing the angle between the line of sight and the inclined axis, just as the circles apparently described by the heavenly bodies increase or diminish according to their polar distance.

Fig. 6276.




*Refracting-Telescopes.*

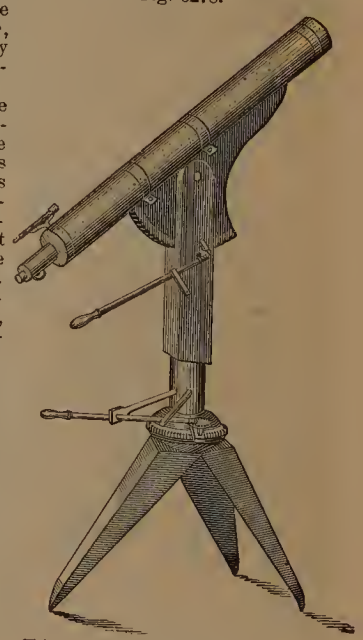
Fig. 6277.

*Telescope Mounted on a Pillar and Claw-Stand.*

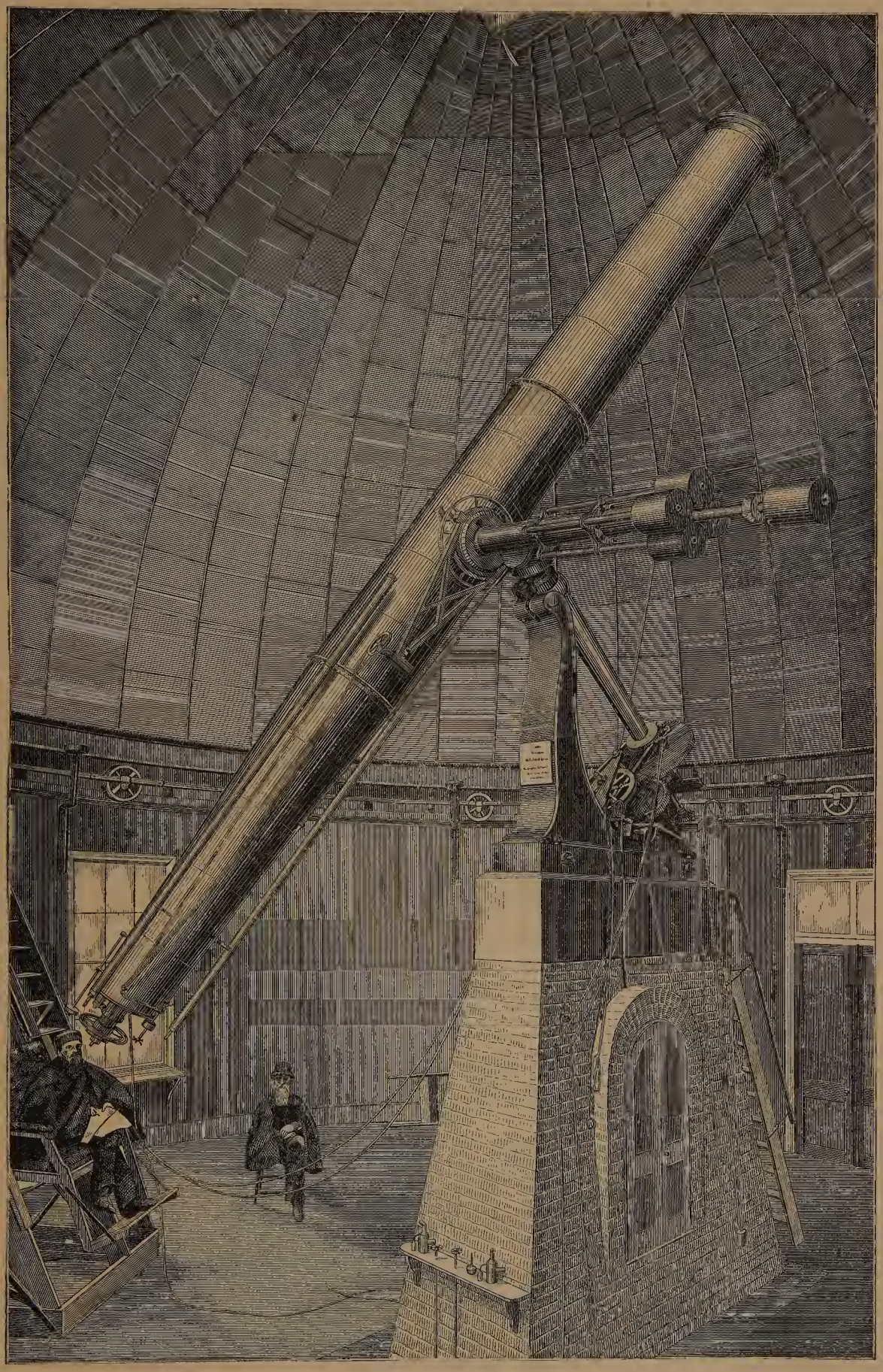
The equatorial of the Cincinnati Observatory was purchased in Munich by Professor O. M. Mitchell, the originator and director of the observatory. The object-glass has a diameter of nearly 12 inches. The death of this talented and Christian gentleman in the service of his country has been a great loss to science and to the social circle, where he was highly esteemed for his modesty and merit.

Large refractors are now universally mounted equatorially, and are made of dimensions which but a few years ago were deemed impracticable. The improvement in this respect is in a large degree due to the exertions of Mr. Alvan Clark, of Cambridgeport, Mass., who, like most other great improvers of the telescope, is a self-taught artist. It would seem that opticians, like poets, are born, not made. Mr. Clark's first object-glasses, strange to say, were made for England, but in 1862 he completed one having a clear aperture of 18½ inches for the Chicago Astronomical Society. This was followed by the great telescope of 26 inches aperture for the United States Naval Observatory

Fig. 6278.



*Telescope with Motion in Altitude and Azimuth.*



EQUATORIAL REFRACTING TELESCOPE AT WASHINGTON, D. C.

PLATE LXIX.

*See page 2524.*

at Washington, completed in November, 1873. Mr. Clark is confident of being able to produce an object-glass of 5 feet 6 inches clear aperture and 75 feet focal length.

The largest that had previously been made were those at the observatories of Cambridge, Mass., and Pulkowa, Russia, each having a clear aperture of 15 inches. These were large in comparison with the instruments that had previously been used, those at Dorpat and Kensington having but 13 inches aperture. In the United States, at that time, among the largest were those at

Cincinnati.....12 inches aperture; 17 feet focal length.
West Point..... 9¾ inches aperture; 14 feet focal length.
Washington..... 9¾ inches aperture; 14 ft. 4½ in. focal length.
Allegheny City ...13 inches aperture.

The disks for Clark's lenses are made by Chance & Co., of Birmingham, England.

The crucibles are of clay, and are built up gradually in rings of about 2 inches in hight, the process requiring a whole year for its completion.

Optical glass of the best quality is then selected and crushed, and the fragments separated according to their specific gravity by a hydraulic separator, in the manner employed for treating ores. Those of uniform quality and size are selected and melted by the most intense heat of a Siemen's gas-furnace; the mass is then cooled very slowly, and the central portion sawn out. This may be reheated until sufficiently fluid, and molded to approximately the desired shape.

The disks are then tested, to ascertain if the glass is homogeneous and free from flaws. This is effected by throwing the light from a lamp through a lens on one side of the disk, and placing the eye in the focus of the lens at the other side. Any imperfections thus appear greatly magnified, and if not removable by grinding, cause the rejection of the piece, at least for a lens of the size for which it was intended. Polarized light also affords a very delicate test as to whether or not it has been equally annealed. The disk is ground upon concave plates of cast-iron of the proper curvature by pushing it back and forth, at the same time giving a slow rotary movement. Emery, with water, is used as an abradant, finer sizes being successively used

The polishing is effected by coating the tool with a thin layer of pitch, which is pressed into the proper shape; this is covered with rouge and water, and the disk manipulated as in the grinding process The pieces forming the lens are, when finished, put together and set on edge, facing a luminous point placed at a distance equal to twelve or fifteen times the focal distance of the lens; the appearance of this point through the lens is examined with an eye-piece of high power, or by the eye placed in the focus, the optician thus judges what parts have an excess or a deficiency of curvature. The polishing process is then repeated upon such portions as are too prominent; the lens is re-examined, and this process repeated until no departure from the proper curve at any point can be detected. This in the case of large lenses is a long and tedious operation, requiring many trials and repetitions of the process The object-glass has but two pieces,—a plano-concave lens of flint and a double convex lens of crown glass.

The Washiugton equatorial (shown in Plate LXIX.) has a clear aperture of 26 inches and a focal length of 31 feet 6 inches, its total length being 32 feet 6 inches. The rough glass for the object-lens was received by Messrs. Clark in December, 1871, and was ground, polished, and finished in November, 1872 Another year was required to finish the tube and complete the other parts of the instrument.

The tube is of thin steel, in three pieces, and is mounted upon a pillar of brick supported by an arched foundation of blue-stone, and capped by a block of sandstone weighing about two tons. The dome inclosing the instrument is 41 feet in diameter and 25 feet high. It rests upon a tower of equal diameter and 21 feet in hight. For lightness, and in order that the temperature may be maintained at that of the air outside, it is made of pine, covered with galvanized iron. It rests upon thirty-two iron rollers, running upon a circular track, and is rotated by a reaction-wheel driven by water from a main of the Washington aqueduct, and operating also the clock-work mechanism and the conical pendulum of the instrument.

The circles are each read by two microscopes reaching from the eye end of the telescope along its sides to the right-ascension circle, which is divided to seconds, the declination circle being divided to tenths of a minute of arc. The instrument has the usual number of eye-pieces and ring micrometer, a filar micrometer, an Airey double-image micrometer, a niea-scale micrometer, and a spectroscope. The disks for the object-glass cost $ 7,000; the whole instrument, about $ 48,000; and the building for its accommodation, about $ 14,000.

Next in size to this is a telescope constructed by Messrs. T. Cooke and Sons of York, England, for Mr. R. S. Newall, the contractor for the first Atlantic cable. This has an object-glass of 25 inches aperture and 29 feet focal length, and is represented as being a superior instrument.

Another English telescope, constructed by Rev. Mr. Craig in connection with Mr. Gravatt, F. R. S., has a 24-inch object-glass, with a focal length of 76 feet, the length of the tube being 85 feet. This was mounted on Wandsworth Common. The great focal length of this appears remarkable, the tendency of late having been to reduce this as far as possible in proportion to the aperture of the lens.

A telescope is now in course of construction in Dublin for the Austro-Hungarian government. Its object-glass will have an aperture of 27 inches, and its total length will be about 32 feet.

The ratio of focal lengths, mode of construction, powers, proportions, adjustments, and mounting are fully explained in many treatises on the subject. See Pearson, Loomis, Heather, Simms, etc., etc.

See under the following heads: —

| | |
|---|---|
| Astronomical telescope. | Newtonian telescope. |
| Binocular telescope. | Object-glass. |
| Cassegrainian telescope. | Opera-glass. |
| Comet-seeker. | Perspective-glass. |
| Equatorial teleseope. | Reflecting-teleseope. |
| Eye-glass. | Refracting-teleseope. |
| Field-glass. | Submarine telescope. |
| Finder. | Teinoscope. |
| Galileau telescope. | Telemeter. |
| Gregorian telescope. | Terrestrial telescope. |
| Herschelian telescope. | Transit-instrument. |

One of the most important applications of the telescope is to instruments for making observations upon the heavenly bodies, both to determine their positions and for ascertaining the latitude and longitude. By means of a very small telescope of low power attached to his sextant, the navigator is enabled to observe with far greater accuracy the contact of the sun's disk with the horizon, or the contact of the limbs of the sun and moon, than he could with the plain sight tube. In fact, the lunar method of finding the longitude would be of little value without the telescope, and the nicety and precision now attained in observations on land, both in astronomical observations and in triangulations for surveys, would be utterly impracticable.

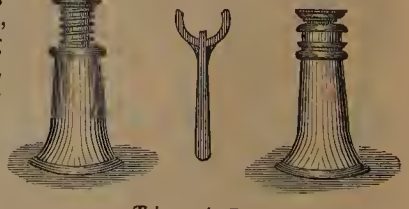
Sir John Herschel says: "The honor of this capital improvement" (the application of the telescope to the measurement of astronomical angles) "has been successfully vindicated by Derham to our young, talented, and unfortunate countryman, Gascoigne, from his correspondence with Crabtree and Horrockes, in his, Derham's, possession. The passages cited by Derham from these letters leave no doubt that, so early as 1640, Gascoigne had applied telescopes to his quadrants and sextants, *with threads in the common focus of the glasses*"; and had even carried the invention so far as to illuminate the field of views by artificial light, which he found "*very helpful when the moon appeareth not, or it is not otherwise light enough.*" These inventions were freely communicated by him to Crabtree, and through him to his friend Horrockes, the pride and boast of British astronomy, both of whom expressed their unbounded admiration of this and many other of his delicate and admirable improvements in the art of observation. Gascoigne, however, perished at the age of twenty-three at the battle of Marston Moor; and the premature and sudden death of Horrockes, at a yet earlier age, will account for the temporary oblivion of the invention. It was revived or reinvented in 1667 by Picard and Auzout (Lalaude, Astron.), after which its use became universal. Morin, even earlier than Gascoigne (in 1635), had proposed to substitute the telescope for plain sights; but it is the thread or wire stretched in the focus, with which the image of a star can be brought to exact coincidence, which gives the telescope its advantage in practice; and the idea of this does not seem to have occurred to Morin.

**Tel'e-scop'ic Boil'er.** (*Steam.*) One formed of several concentric cylindrical portions.

**Tel'e-scop'ic Chim'ney.** (*Nautical.*) One which is in sections slipping into each other, to be lowered in time of action, or, in certain river-steamers, in passing beneath bridges.

**Tel'e-scop'ic Jack.** A screw-jack in which the lifting head is raised by the action of two screws having reversed threads, one working within the other, and both sinking or telescoping within the base. By this differential arrangement greater power is obtained.

Fig. 6279.



*Telescopic Jack.*

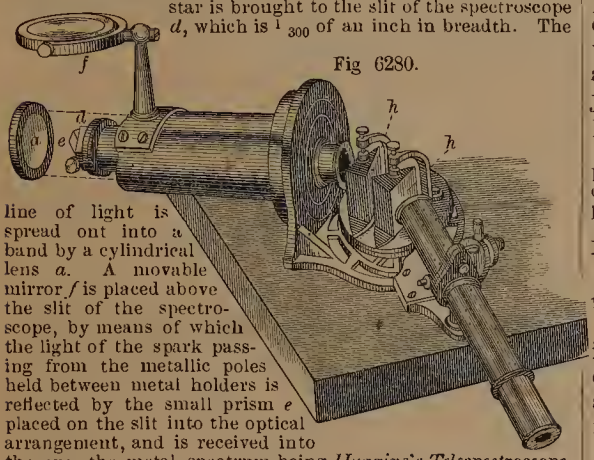
**Tel'e-scop'ic Lens.** A compound lens suited for the *eye* or *object-glass* of a telescope. Terrestrial telescopes, or spy-glasses, have two additional lenses, enabling an object to be seen in its natural instead

of an inverted position. See LENS; EYE-GLASS; OBJECT-GLASS; TELESCOPE; etc.

**Tel'e-spec'tro-scope.** An instrument for observing the light from the planets and fixed stars, for ascertaining their physical condition and the composition of their atmospheres.

At the end of the telescope is placed the spectroscope (Fig. 6280), which contains two prisms *h h*, while the image of the star is brought to the slit of the spectroscope *d*, which is $\frac{1}{300}$ of an inch in breadth. The

Fig 6280.




line of light is spread out into a band by a cylindrical lens *a*. A movable mirror *f* is placed above the slit of the spectroscope, by means of which the light of the spark passing from the metallic poles held between metal holders is reflected by the small prism *e* placed on the slit into the optical arrangement, and is received into the eye, the metal spectrum being ranged close above that derived from the star, so that the coincidence or otherwise of the two sets of lines can be accurately observed.

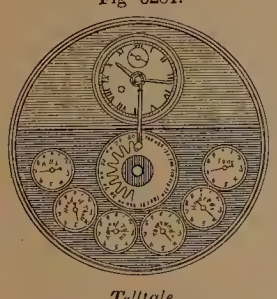
*Huggins's Telespectroscope.*

**Tel'e-ster'e-o-scope.** An instrument described by Helmholtz, 1857, for producing an appearance of relief in the objects of a landscape at moderate distances.

It consists of a frame on which are set at a convenient distance — say 4½ feet — apart two plane mirrors at an angle of 45°, which receive the rays of light from the objects; these are reflected to two central mirrors, forming an angle of 45° with the first, in which they are viewed by the eye. The effect produced is the same as if the eyes of the observer were at the same distance apart as the two larger mirrors. When objects at a great distance are viewed, they do not appear in strong relief, but rather as if detached from the general landscape. — *Annales de Chemie*, 3d series, Vol. LII. p. 118.

**Tell'tale.** 1. A device for counting, indicating, detecting, or verifying.

Fig 6281.



*Telltale.*

2. (*Nautical.*) *a.* See TELLTALE-COMPASS.

*b.* An index in front of the wheel, or in the cabin, to show the position of the tiller.

3. (*Music.*) A movable piece attached to an organ to indicate when the wind is nearly exhausted.

4. (*Gas-making.*) A device attached to a station-meter to point out any irregularity in the production of gas.

It consists of a circular plate placed centrally in the dial-*field* and carrying a paper disk, and connected by gearing with the wheel which turns the hand belonging to one of the dials of the meter. Above it is a clock, to whose minute-hand is attached an arm carrying a pencil pushed against the paper disk by a spring. If the paper disk were stationary, the pencil would thus be caused to make a vertical stroke up and down each hour, but as the disk slowly turns with the dial-wheel, to which it is connected, the pencil traces a series of curves which are closer together or farther apart in proportion to the quantity of gas passing through the meter. If the quantity of gas produced has been uniform, the apexes of the curves will be equidistant from each other at the margin of the disk; if otherwise, their distances will vary, being nearer together when less than the usual quantity passes through the meter, and farther apart when the normal amount is exceeded.

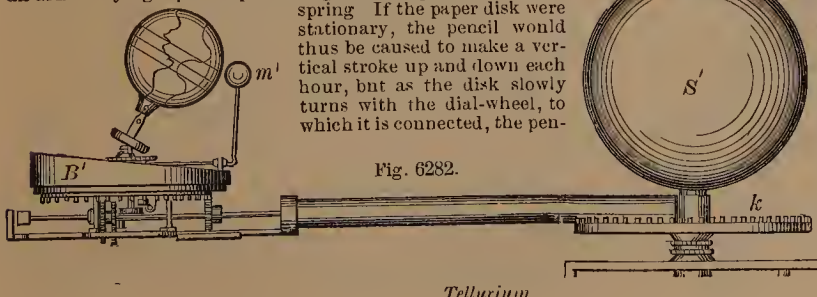



Fig. 6282.

*Tellurium.*

5. (*Horology.*) A clock attachment for the purpose of causing a record to be made of the presence of a watchman at certain intervals. Arésa's is provided with a rotating paper dial, showing the hour and minute at which the watchman touched a projecting button having a point which punctures the paper dial.

Smith's has a rotating circular frame, fitted with springs and pins; the operative mechanism must be touched at certain definite intervals in order that these shall appear in their proper places when inspected in the morning.

A *telltale* clock is described in English patent No. 1,502 of 1856. See also WATCHMAN'S TIME-DETECTOR.

6. A turnstile having mechanism which indicates the number of passengers.

**Tell'tale-com'pass.** (*Nautical.*) A compass is suspended overhead in the cabin. The face of the card is downward, so that it is visible from below, and enables the captain to detect any error or irregularity in steering. See HANGING-COMPASS.

**Tel-lu'ri-an.** *Tellurion.* See TELLURIUM.

**Tel-lu'ri-um.** The preferable spelling, in consonance with *planetarium, lunarium. Encyc. Brit.*, XVII. 753.

An apparatus for the purpose of illustrating to the eye the real and apparent movements of the earth; exhibiting the ellipticity of the earth's orbit; the position of the sun (represented by a lamp in one of the foci of that ellipse); the inclination of the pole to the plane of the ecliptic, and the constancy of the pole during the entire yearly revolution; the apparent movement through the constellations of the zodiac; the phenomena of eclipses, day and night, sunrise and sunset, and the seasons; the varying declination of the sun; the equation of time; the motions and phases of the moon; and affording a model whereon to illustrate the theory of the tides, lunar disturbances, etc.

See No. 66,791, Campbell, July 26, 1867.

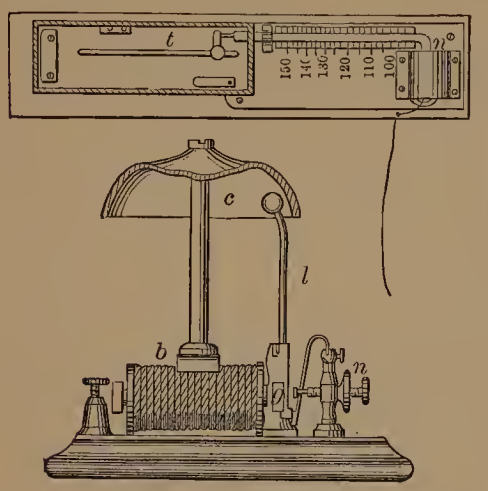
In Davis's tellurium (Fig 6282), a ball *S'* representing the sun is attached to an upright shaft rotated by a crank through the medium of intermediate gearing, and passing through a sleeve rotated by gearing driven by the same crank, and carrying a toothed disk *k* engaging a rod passing through a horizontal tubular arm attached to and at right angles to the sleeve. The rod has a series of wheels at its outer end, which impart a rotary motion to the ball representing the earth, placed on an arm inclined at an angle of 23° 28' therewith, to the beveled disk *B'*, and to the moon *m'*; the bent stem on which the latter is mounted is connected with an eccentric ring, causing it to move in an elliptic orbit around the earth; it has also a friction-wheel, which, traveling around the inclined edge of the disk *B'*, produces an alternate ascent and descent of the moon, illustrating its changes of declination; the parts by which the moon is revolved are also so adjusted as to exhibit the retrogression of their nodes.

See also ORRERY, pages 1577, 1578; PLANETARIUM, page 1727.

**Tel-o-dy-nam'ic Ca'ble.** A means for transmitting power, originated by Hirn of Logelbach, in which high speed is employed to give the momentive effect of great mass.

The motor is made to give a high velocity to a pulley-wheel, and this wheel is employed to carry a cable which passes over another pulley at the point where the power is to be applied for use. The cable may be lighter in proportion as the velocity with which it travels is greater. Theoretically, there is no limit to the reduction in size, if sufficient velocity be imparted to give the

Fig. 6283.




*Electro-Magnetic Temperature-Alarm.*

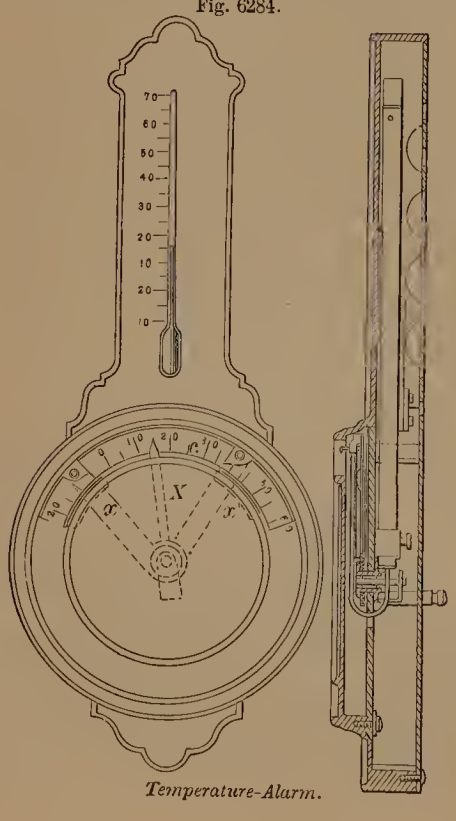
requisite momentum, but in practice this is governed by the velocity with which the pulleys may be safely run, and the strength required by the cable for overcoming the inertia of the pulleys, the friction on their axes, and the resistance of the air, and also the friction of the smaller pulleys on which it must be supported when the distance is considerable. The cable used is of wire, generally about 4 inch in diameter, and is supported at intervals of about 150 yards in grooved pulleys protected by gutta-percha The large transmitting and receiving pulleys at the ends are about 4 meters (13⅓ feet) in diameter, making from 150 to 200 revolutions per minute; the cable consequently travels at the rate of 50 to 75 miles an hour. See WIRE-ROPE; WIRE-WAY

This mode of transmitting power was first successfully employed about 1852, and has since been somewhat extensively introduced into France and other countries.

In the government powder-mills at Okhta, Russia, 274 horse-power, derived from turbines, is thus carried over 4,600 feet; at the mines of Fahlun, Sweden, over 100 horse-power is transmitted nearly 3½ miles. Some have been put up in this country. One at Lockport, N. Y., transmits 25 horse-power 700 feet over pulleys 5 feet in diameter.

The power lost by friction of the two great pulleys has been ascertained to be 2½ per cent, by the smaller pulleys and rigidity of the cable 1 per cent, for each 1,000 meters; to this must be added the resistance of the air. It was calculated by the inventor that all these together would entail a loss of 25 per cent in a length of six miles, leaving 75 horse-power available at that distance out of 100 originally applied; this is, however, thought to be an overestimate.

Fig. 6284.




*Temperature-Alarm.*

**Tel'o-type.** (*Telegraphy.*) A printed telegram.

**Tem'o-in.** (*Engineering.*) A pillar of earth left in an excavation to show how much earth has been removed.

**Tem'per.** 1. An alloy used by pewterers: tin, 2; copper, 1. See ALLOY.

2. The particular condition, as to hardness, of steel. See TEMPERING.

3. Milk of lime, or its equivalent, added to boiling sirup to clarify it.

**Tem'per-a-ture-a-larm'.** A device which automatically makes a signal when the temperature of the place where it is located exceeds or falls below a determinate point.

In Fig. 6283, one end of a wire, attached to a slider on the rod *t*, is set to a certain degree in the tube of the bent thermometer *n*, the other end being connected with one of the poles of an electro-magnetic coil *b*. A second wire, inserted into the bulb of the thermometer, leads to the other pole. When the mercury rises so as to touch the other end of the first wire, the circuit is completed, and the armature *g* of the electro-magnet, which turns on a spring axis, operates the rod *l*, sounding the bell *c*.

In Fig. 6284, the expansion and contraction of a metallic thermometer, through the medium of a segment rack and pinion, operate an index *X*, which, on coming in contact with a projection upon either of two arms *x x'*, closes an electric circuit and operates an alarm. These arms are independently adjustable toward and from the central point of the index *c*, so as to permit various maxima and minima. See also THERMOSCOPE; THERMOSTAT; THERMOSTATIC ALARM; etc.

**Tem'per-er.** A machine in which articles are ground together, with the addition of a proper quantity of water, to intimately commingle them and develop the plasticity. Sand and lime thus tempered form mortar; clay thus tempered becomes fit for the potter's use. The machine used by Coignet in compounding his *béton* is called a *malaxator*.

Machines for compounding flour and water into dough are substantially similar, and are called *kneading-machines*. See pages 1230, 1231.

**Tem'per-ing.** (*Metal-working.*) The process of producing in a metal, particularly steel, that peculiar degree of hardness and elasticity which adapts it for any of the purposes to which it is to be applied.

The malleable metals generally increase in hardness by being hammered or rolled, and *hammer-hardening*, that is, hammering without the application of heat, is frequently employed for hardening some kinds of steel springs.

Steel, however, is for most purposes hardened by plunging it while hot into water, oil, or other liquid, to cool it suddenly.

One of the earliest notices of this art is a simile in the Odyssey, "As some smith plunges into cold water a loudly hissing axe, tempering it."

The notices of the early use of *bright iron* are given under the caption STEEL.

Bronze is tempered by a process reverse to that adopted with steel. Cooling bronze slowly hardens it. The sudden cooling makes it less frangible, and is adopted with gongs. Dr. Faraday made the remark many years since. By a careful process of alloying, tempering, and hammering, bronze may be made as hard as steel, and make excellent springs.

Pliny (A. D. 701) recommends *oil* for tempering steel; he states that *water* makes it brittle.

Metals, in general, suffer no apparent change when heated to redness and suddenly cooled. Pure malleable iron remains entirely unaffected, but when combined with proportions of carbon variable within certain limits, forming steel, it possesses this property of being hardened when suddenly cooled, and being again softened by reheating and slowly cooling to an eminent degree, giving it that pre-eminence which it enjoys over

all other metals for forming weapons, tools, aud many other articles. This quality, which appears to be due to molecular changes in the metal caused by great changes of temperature, is to a certain exteut participated iu by cast-iron which contains a much larger proportiou of carbou, and may be superficially hardened by chilliug; without, however, again beiug softened by a second applicatiou of heat.

Thiu plates of steel may be hardened by placing them betweeu two good conductors of heat, as a hammer and anvil. Thicker pieces become moderately hard when exposed to the air upou the anvil. If laid on cold ciuders or other poor conductor, they become softer, and still more so if placed in hot ciuders, or are otherwise very gradually cooled. By heating iu closed boxes with charcoal, and very slowly cooling, the metal is reduced to its softest state; by using irou turnings or fine scale from the forge, lime, or other matter which will combine with the carbon, its surface may be reconverted iuto malleable iron, as is done in Perkins's process for transferring steel engravings. See BANK-NOTE ENGRAVING, page 228; ANNEALING, pages 111 - 114, STEEL-PLATE ENGRAVING.

Great diversity exists in opinion and in practice as to the best method to be adopted in each particular ease. The following principles are, however, generally agreed on: —

The lowest available temperature should be employed in forging and tempering steel; the hammering should be applied equally throughout, and for cutting tools should be continued until they are nearly cold.

Coke or charcoal is much better for fuel than coal, the sulphur iu which is apt to be injurious.

The scale should be removed from the face of the work to expose it more uniformly to the cooling medium

Hardening a second time without rehammeriug should be avoided, and the less frequently the steel passes through the fire the better.

The smallest works are heated with the flame of the blowpipe, and are occasionally supported on charcoal. Larger works, which are yet too small to be conveniently exposed to the open fire, are protected by an iron tube or box, which is placed in the fire. A crucible or iron pot filled with lead and heated to redness is excellent for long, thin tools, such as artist's gravers Sometimes a pan filled with charcoal dust aud heated to redness on the fire is used.

Many articles are heated in the ordinary forge-fire. The bellows should be used sparingly, and the work should be allowed ample time to get hot, or *soak*, as it is termed. The piece should be uniformly heated by moving it about to expose all parts to the fire, and it is better that it should be rather underheated than over-heated, as the latter involves the risk of burniug the metal, while in the former case the defect may be corrected by a second beating. Too little heat fails to produce hardness, and in the opinion of some has an opposite effect. It is consequently resorted to for lowering the temper, the steel in this case being dipped into water, suddenly withdrawn, held a few moments in the steam, again dipped, and similarly treated, and so on until cool.

Various liquids and compounds have been recommended for hardening. Plain water is that generally used, and that which has beeu long in use is preferred. The common opinion is that mercury gives the greatest degree of hardness: then cold salt water, or water mixed with astringent or acidifying matters; then plaiu water; and lastly, oily mixtures.

These last are generally used for springs and thin artieles, aud in some cases water covered with a film of oil is employed A very high degree of hardness is said to be imparted to gravers, watchmaker's drills, and like small tools by plunging them while hot into a stick of sealing-wax, withdrawing them, and repeatiug the operation until they become too cool to penetrate Steel pens are hardened in an oily mixture, and generally tempered in oil or an oily mixture, the boiling point of which is of the proper temperature to let the temper down, or in a dry oven, where a lesser heat may be imparted. Saws and springs are generally hardened in various compositions of oil, suet, wax, and other ingredients, which are partially wiped and afterward burnt or *blazed* off. Gunlock springs are sometimes fired in oil over a fire in an iron tray to let down the temper. Watch-springs are hardened in oil and *blazed* off: they are then stretched in a frame and polished, which appears to have destroyed the elasticity; this is, however, afterward restored by hammering. It is said that Damascus sword-blades are hardened by heating to a certain temperature, and then waving them in a draft of cold air.

Files, previous to being hardened, are drawn through beer-grounds, yeast, or other stieky matter, and then through common salt, mixed with cows' hoof previously roasted and pouuded, which serves to protect the teeth against the direct action of the fire. This lesseus the tendeney to crank, and the fusion of the salt also indicates the proper heat for hardening. The temper of the tang is afterward *drawn* to render it less brittle.

Needles are tempered by exposure to heat on an iron plate over a fire. They are kept in motion by an iron shovel till the blue color appears, when they are instantly removed.

A convenient method of tempering small articles is by a flat bar of iron heated to redness at one end; these are placed on a part of the bar which is at the required heat until they assume the proper color. A number may thus be operated on at once, being gradually pushed forward from the cooler to the hotter parts of the bar.

The heat required for letting down the temper is judged of by the color of the film of oxide which forms upon the surface of the steel when it is reheated after hardeniug. For this purpose a portion at least of the metal must have a bright surface. This, as the metal becomes heated, assumes the following colors: 1, pale yellow, deepening into a straw yellow; 2, full yellow; 3, the color deepens to purple, copper, brownish purple; 4, deepens iuto violet; 5, indigo blue to dark blue; 6, lighter blue to sky blue; 7, the blue becomes greenish, producing shades of gray aud sea green; 8, the steel reddens.

These colors form a sure guide for the workman, who has only to remove the article from the fire, when it assumes the desired color, and immerse it in cold water; this, however, is sometimes dispensed with.

The following tabular statement shows the colors and degrees of heat proper for tempering various articles of steel: —

| | | |
|---|---|---|
| 1. Very pale straw yellow | 430° | Tools for metal. |
| 2. A shade darker of yellow | 450° | |
| 3 Darker straw yellow | 470° | Tools for wood, screw-taps, etc. |
| 4 Still darker straw yellow | 490° | |
| 5. Brown yellow | 500° | Hatchets, chipping-chisels, and other percussive tools, saws, etc. |
| 6. Yellow, tiuged slightly with purple | 520° | |
| 7. Light purple | 530° | |
| 8. Dark purple | 550° | Springs. |
| 9. Dark blue | 570° | |
| 10. Paler blue | 590° | Too soft for the above purposes. |
| 11. Still paler blue | 610° | |
| 12. Still paler blue, tinged with green | 630° | |

It has been proposed to employ in tempering, alloys composed of lead and tin in such proportions that the fusing-point of each alloy should correspond to the letting-dowu temperature proper to each class of articles to be tempered.

Garman and Seigfried's process of working and tempering steel consists in heating it to a cherry red in the forge, then covering it with salt; salt is also thrown into the fire, and the steel is worked until it is nearly brought to the finished form. The steel is then covered with a mixture of one part each by weight of salt, sulphate of copper, sal ammoniac, and sal soda, with ½ part of nitrate of potash, heated and hammered; being thus alternately treated with the composition, and heated and hammered until it assumes its finished form. It is then slowly heated to a cherry red and plunged into a bath composed of rain water, 1 gallon; alum, 1½ ounces; sulphate of copper, 1½ ounces; sal soda, 1½ ounces; nitrate of potash, 1½ ounces; salt, 6 ounces. These proportions may be slightly varied.

Large articles are very liable to crack if removed from the hardening bath before becoming cool, owing to the unequal contraction of the interior and exterior portions.

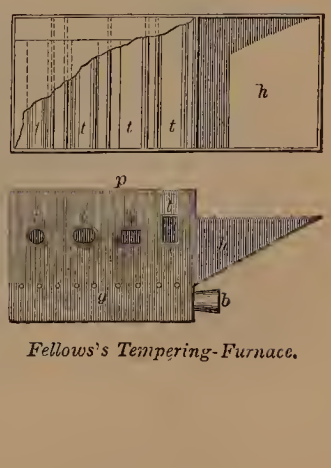
To avoid this they should be, if not already, protected by a coating of scale covered with soft soap, graphite, plumbers' size, or other suitable substance. When heated in a common fire, prussiate of potash is to be preferred. This is powdered and sprinkled or sifted uniformly over the surface of the article, which is then heated to the proper degree and dipped in the water; when extra large, a second coating and heating may be advisable.

Steel heated to redness and suddenly cooled becomes too hard — *glass hard*, as it is termed — for most purposes. Files are left in this state. Most other articles are reheated to a greater or less degree, and again cooled in a bath of some suitable substance. This constitutes the *tempering*, or *letting down* the temper.

In some eases the hardening and tempering are done at a single operation, the piece being heated only to 700°, 800°, or 900° Fah., and then plunged into water; in others the tempering heat is derived from that portion of the piece which has not been cooled, which, when the article is removed from the bath again, heats up the cooled part to the proper temperature for tempering by re-immersion.

Instead of hardening by immersion and reheating to lower the temper, it has also been recommended to use water just sufficiently hot to produce the desired temper at once. The proper heat varies according to the kind of steel and the size of the articles. For springs for the needle-gun a temperature of about 130° Fah. has been employed. For some kinds of steel, boiling water is used. Cooling in hot water is said to increase the tenacity and elasticity of steel containing 0.2 to 0.4 per cent carbon, without much affecting its hardness.

Fig. 6285.



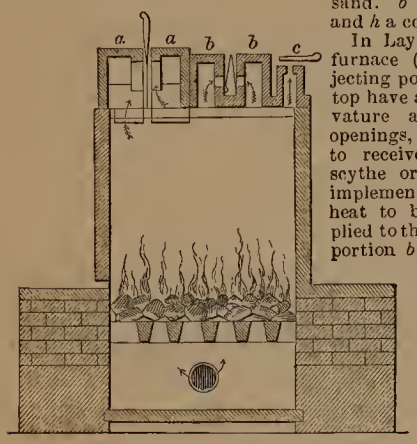

*Fellows's Tempering-Furnace.*

**Tem'per-ing-fur'-nace.** (*Metal-working.*) One specially

contrived for imparting an equal heat to the articles to be tempered.

Fellows's has a series of tubes *t* over the grate *g*, in which the articles are placed to heat for hardening. To lower the temper, they are placed on a plate *p*, which is covered with sand. *b* is the blast-pipe, and *h* a coal-receptacle.

Fig. 6286.




*Layton's Tempering-Furnace.*

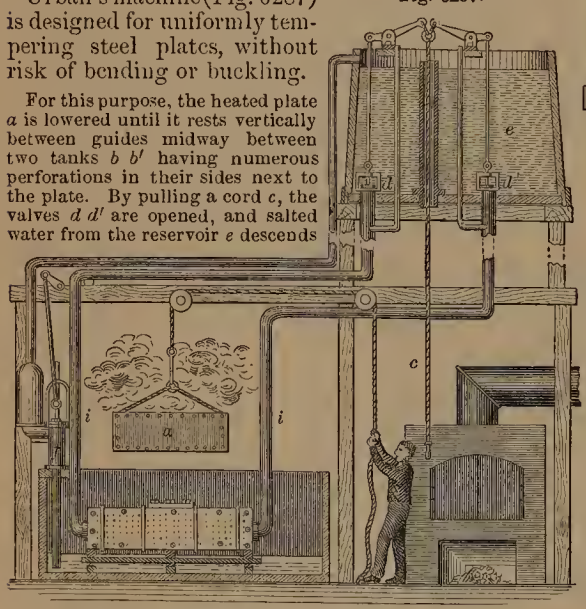
In Layton's tempering-furnace (Fig. 6286), projecting portions *a a* of the top have a downward curvature and longitudinal openings, adapting them to receive the edge of a scythe or similar curved implement, enabling the heat to be uniformly applied to the blade; another portion *b b* has openings to which the heat is admitted through side apertures, and applied at particular spots in the blade, to rectify irregularities in the temper; at a third opening *c* the heat may be applied to the flat of the blade.

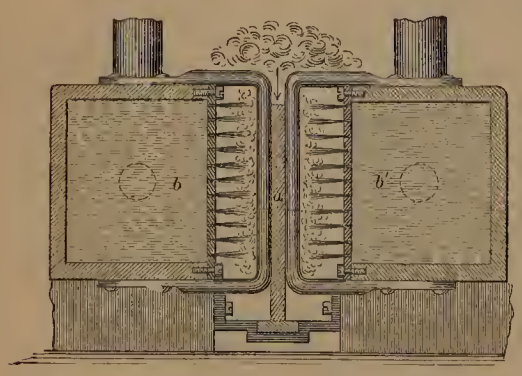
**Tem'per-ing-ma-chine'.** One for handling heavy steel plates during the operations in tempering.

Urban's machine (Fig. 6287) is designed for uniformly tempering steel plates, without risk of bending or buckling.

Fig. 6287.

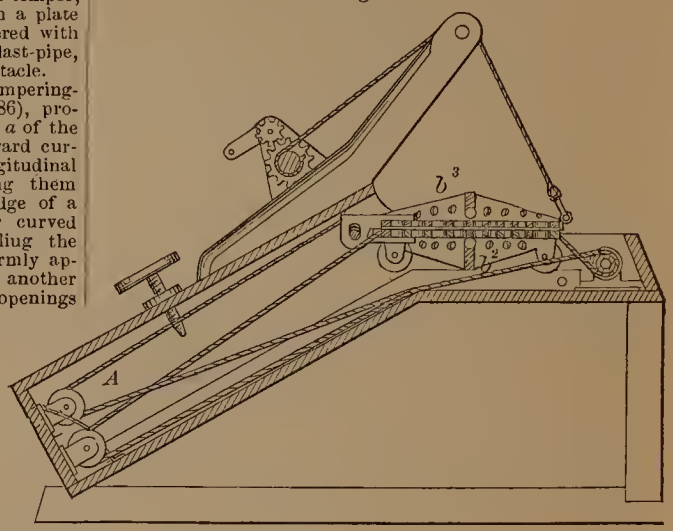
For this purpose, the heated plate *a* is lowered until it rests vertically between guides midway between two tanks *b b'* having numerous perforations in their sides next to the plate. By pulling a cord *c*, the valves *d d'* are opened, and salted water from the reservoir *e* descends through the pipes *i i* into the tanks, playing in jets against both sides of the plate; a pump *f* returns the water from the lower reservoir to the upper one, in order that it may be used again.

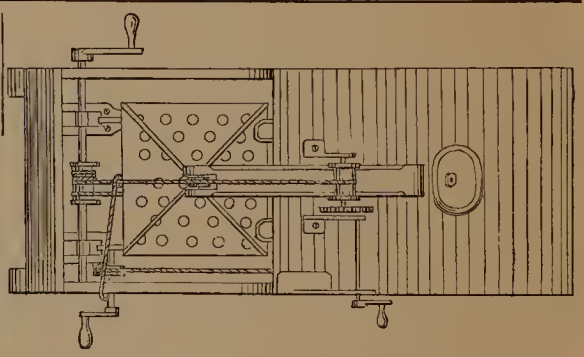



*Urban's Tempering-Machine.*

Fig. 6288.



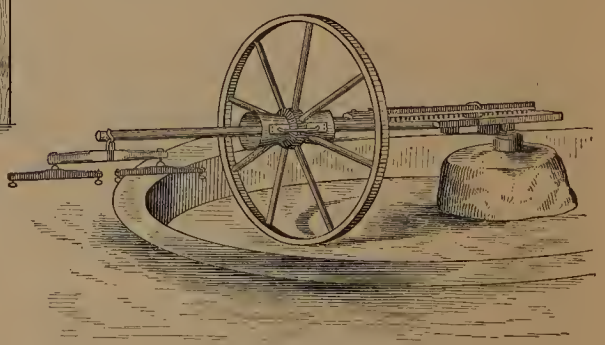



*Mercer and Hinton's Machine for Tempering Saw-Plates.*

In Mercer and Hinton's machine (Fig. 6288) for tempering saw-plates, the plate is clamped between two perforated plates, strengthened by ribs $b^2$ $b^4$, forming a carriage which runs on rails down into the bath *A*. The carriage is raised or lowered by means of a rope or chain passing around pulleys and operated by a winch.

In Crossman's machine for tempering scythe-blades, the blade, after being properly heated, is placed between two jaws, which are forced together by depressing a treadle, clamping the blade, and at the same time immersing it in a tank beneath.

Fig. 6289.



*Tempering-Wheel.*

**Tem'per-ing-wheel.** A device for inking and tempering clay for making brick, etc. The wheel is of cast-iron, and revolves on an axis, one end of which is pivoted to an upright in the center of a circular pit, and the other has means of attachment for a horse or horses. A rack and gear-wheels connected with the axle cause the wheel to alternately approach and recede from the center of the pit dur-

ing its onward movement, exposing every part of the clay to its action.

**Tem'per-screw.** 1. (*Well-boring.*) A piece by which the tools are suspended from the walking-beam, and are lowered as the drilling progresses.

2. A *set*-screw for adjustment. One which brings its point against a bearing or an object.

**Tem'plate.** See TEMPLET.

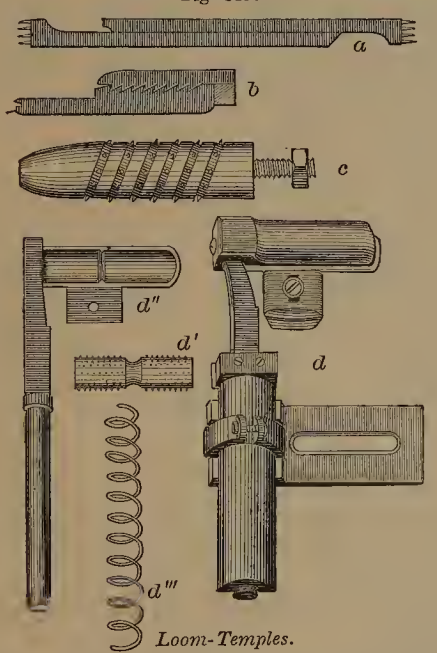
**Tem'ple.** 1. (*Weaving.*) An instrument for keeping cloth its proper breadth while the reed beats up against it in the process of weaving. In a loom weaving 100 picks per inch, the vibration of the reed being 4 inches, the reed passes over each portion of the warp-threads 800 times. If, therefore, the cloth be not extended so as to bring the warps nearly parallel to the motion of the reed, the selvedge-threads become chafed.

To obviate this difficulty the temple is designed.

The old form is shown at *a*. It consists of two pieces of hard wood with points at the ends to catch the selvedge at either side. They are adjusted as to length for the width of the goods.

*b* shows Stillman's jaw temple, patented in 1826. The cloth was released and allowed to slide forward when the lay was full up against it, and shut together, holding it out to a proper width when the lay retired. *b* shows the part which held the cloth.

Fig. 6290.




*Loom-Temples.*

The first rotary temple was patented by Ira Draper in 1816. In this, the cloth was held by a horizontal wheel having a row of teeth set obliquely to its axis. It was improved in 1829 in fastening it to the breast-beam by a spring to give it elasticity. George Draper's patent of 1840 added another row of teeth to prevent its leaving a track in the cloth.

*c* is the Kayser temple which holds the cloth extended by needle-pointed rings turning at an oblique angle to the plane of the breast-beam, thereby automatically stretching the cloth as it passes through.

*d* is the "Dutcher" temple, now in general use. It has small cylindrical toothed rolls holding the cloth by two or more inches of its breadth. It works nearer to the reed than the others, and has a reciprocating action whereby the lay beating against it produces a motion corresponding with and equal to the motion of the cloth. The lower figure shows several parts, — the spiked roller $d'$, its case and bar $d''$, and the spring $d'''$ detached; also the device *d* complete.

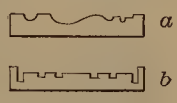
2. One of the bars on the outer ends of the spectacle bows by which the spectacles are made to clasp the head of the wearer.

**Tem'plet.** 1. A mold or pattern used by molders, bricklayers, machinists, etc., in laying off their work. It frequently consists of a flat, thin board, whose edge is dressed and shaped to the required conformation, and is laid against the object being molded, built, or turned, so as to test the conformity of the object thereto.

In the examples, *a* is a *templet* for a *baluster*, which is turned in a lathe.

*b* is a templet for a steam-engine cylinder, the mold of which is made of *loam work*. See CASTING.

Fig. 6291.




*Templets.*

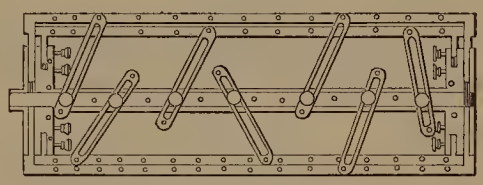
*Templets* or pattern plates of hardened steel are used for testing the progress and perfection of curved works that are shaped by the file. Sheet-metal works, not required in sufficient quantity to make punches and dies for their production, are fashioned between *templets* in a vice.

The templet for forming the striking wheel of a clock has 12 steps arranged spirally on its edge. A number of brass disks are clamped between two of such templets, and then dressed by a file in correspondence with the pattern at each end of the pack.

In making lenses, *templets* of sheet-brass are first made corresponding to the curves of the lenses. These templets are used in making the *shells* and *runners*, between which the lenses are ground to shape.

Perforated templets are used by boiler-makers and others to lay out the holes for punching. In order to allow one section

Fig. 6292.



*Adjustable Templet.*

of pipe to slip into another, the holes around the plate are not punched in rectangular patterns.

Williams's adjustable templet has movable perforated side bars, combined with T-shaped heads upon the central bar; also adjustable and perforated slides combined with each other and with the central bar.

2. (*Shipbuilding.*) *a*. A mold of a certain figure to test or direct the conformation of a timber or other object.

*b*. A perforated piece or strip by which a line of rivet-holes is marked on a plate to be punched.

*c*. One of the wedges in a building-block.

3. (*Building.*) *a*. A short piece of timber or large stone placed in a wall to receive the impost of a girder, brestsummer, or beam, and distribute its weight; a wall-plate; a *torsal*.

*b*. A plate spanning a window or door space to sustain joists and throw their weight on the piers.

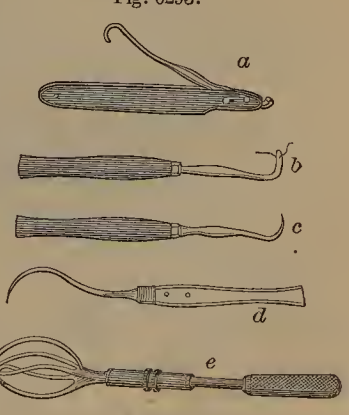
4. (*Weaving.*) The templet of the horsehair-loom is a pair of jaws for each selvedge. See TEMPLE.

**Temse.** (*Milling.*) A bolting cloth or sieve. *Tamise.*

**Ten.** (*Mining.*) A measure (local) containing 420, and in other cases 440 bolls, Winchester measure.

**Te-nac'u-lum.** (*Surgical.*) *a*. A fine hook, attached to a handle, which is thrust through the parietes of a blood-vessel to draw it out and enable it to be tied.

Fig. 6293.




*Tenacula.*

*a*, pocket-tenaculum.
*b*, aneurism-tenaculum.
*c*, aneurism-needle.
*d*, ordinary tenaculum.
*e*, tenaculum-forceps.

The double tenacula (Fig. 6294) consist of two hooks, pivoted after the

Fig. 6294.

*Double Tenacula.*

manner of scissors, for more effectually holding the ends of a severed artery.

*b. Bone-nippers.*

**Te-nac'u-lum-for'ceps.** (*Surgical.*) An instrument, known as Assalini's tenaculum, for grasping the parietes of an artery, to facilitate tying. The instrument has a pair of bifurcated claws which close into each other upon the artery by the force of a spring.

The tenaculum-forceps with a sliding ring was used in old Rome. One was disinterred at Pompeii in 1819 by Dr. Cavenko of St. Petersburg, in the Via Consularis. It is pictured in Smith's "Dictionary of Antiquities," page 274, and is in the Museum of Portici.

*e* (Fig. 6293) is an instrument invented by Prince, which acts the part of a tenaculum and forceps combined. The upper bow is that of the tenaculum, and beneath it are the bow jaws of the forceps. The blades of the jaws are made wide enough to stop the bleeding, and when the noose of the ligature is over the largest swell of the blades, it slides into its position without catching upon the point of the tenaculum.

**Te-naille'.** 1. (*Fortification.*) A low work located in the ditch and in front of a curtain to protect the curtain and flanks of the bastions. A passage is left between each end and the adjacent flank. See BASTION.

2. (*Surgical.*) Nippers: *tenaille incisive*, cutting nippers; bone nippers.

*Tenettes.* Craniotomy forceps.

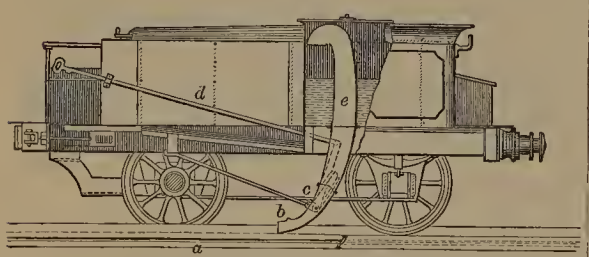
**Te-nail'lon.** (*Fortification.*) A low outwork having a salient angle; it was formerly usual to place one on each side of a ravelin to increase its strength and cover the shoulders of the bastion.

**Ten'ant-saw.** See TENON-SAW.

**Tend'er.** 1. (*Railroading.*) The carriage which is attached to a locomotive and contains a supply of fuel and water. See LOCOMOTIVE.

In 1854, Angus W. McDonald, of New Creek Depot, Va., patented a plan for filling the tanks of locomotive tenders with water without stopping the train, by using an inclined scoop, which was caused to dip into reservoirs placed at suitable in-

Fig. 6295.

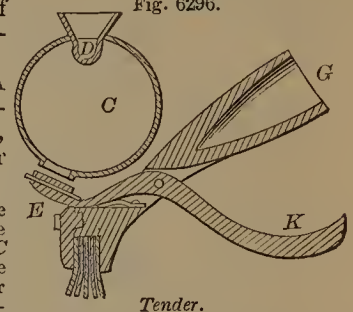



*Self-Supplying Tender.*

tervals alongside of or beneath the track. This method, which met with little favor in this country, has been adopted on several English railways. As there practiced, a long water-trough *a*, made up of cast-iron sections, is laid upon the sleepers between the rails, and at such an elevation that the scoop *b* may be immersed into the water a depth of two inches, just equal to the depth of its mouth, which has a width of 10 inches. The scoop is hinged at *c*, and, when not in use, is tilted upward by a counterbalance weight. When one of the supply-troughs is approached, the scoop is depressed by means of the rod *d*, and the onward movement of the train causes the water to rush into the mouth and be forced up the delivery-pipe *c*, having a downwardly opening mouth through which it is discharged into the tank. On releasing the handle of the rod *d*, the scoop ceases to operate.

2. (*Nautical.*) A small vessel employed to tend upon a larger one, with supplies of provisions, to carry dispatches, to assist in the performance of shore duty, in reconnoitering, etc.

Fig. 6296.




*Tender.*

3. (*Household.*) A small reservoir attached to a mop, scrubber, or similar utensil.

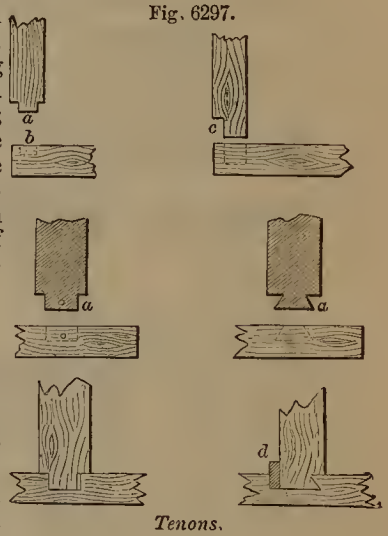
In the example, the socket *G* receives the mop-handle, the tender *C* is supplied through the trough *D*, and the water is caused to flow by compressing the arm *K*, opening the valve *E*, which is afterward closed by a spring.

**Ten'der Por'ce-lain.** A ware composed of a vitreous frit rendered opaque and less fusible by addition of calcareous clay. Its glaze is a glass of silica, alkali, and lead.

**Ten'do-tome.** (*Surgical.*) A subcutaneous knife, having a small oblanceolate blade on the end of a long stem, and used for severing deep-seated tendons without making a large incision or dissecting down to the spot. See TENOTOME.

**Ten'on.** (*Carpentry.*) The projecting end of a piece of timber fitted for insertion into a mortise, formed by cutting away a portion on one or more sides; sometimes made cylindrical. The usual joint in putting up wooden frames, whether of buildings or machines.

Fig. 6297.




*Tenons.*

*a*, tenon.
*b*, mortise.
*c*, relish.
*d*, dovetail tenon and key.

Tenons are secured in their mortises by pins, or by giving them a dovetail, which is driven into the undercut mortise by means of a wedge or backing-block *d*.

Fig. 6298 shows tenons of various forms.

A tenon on the top of a post to receive two beams meeting each other at right angles is a *tease*-tenon.

**Ten'on-au'ger.** The ends of movable blind-slats are usually turned down to a round tenon by a hollow auger *a* (Fig. 6299). The end of the tenon is afterward dressed by a *bur b*; *c* is a shoulder-bur.

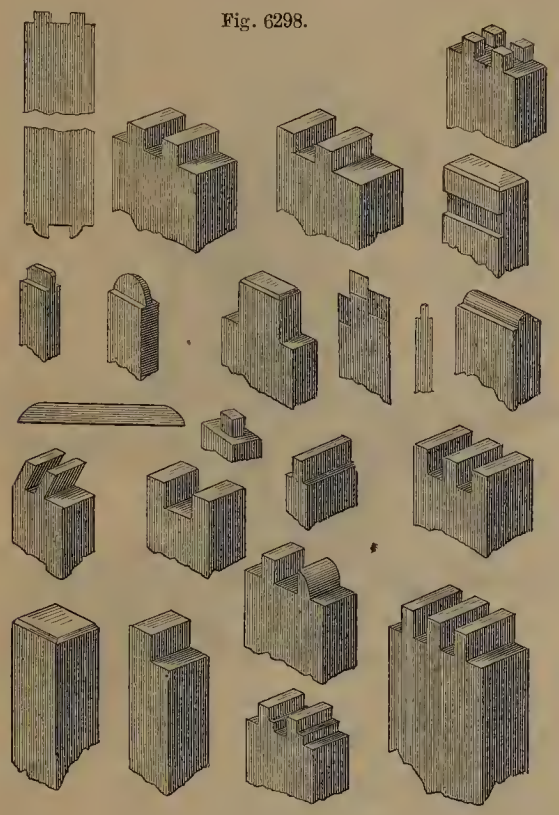
Ellis's blind-slat tenoning-machine operates by a pair of equalizing saws upon each end of the tenon, cutting the shoulders, rounding the tenon, and cutting the slab to a length at one operation.

In Fig. 6300, the cutter is obliquely placed in the snail-shaped holder, so as to make a draw-cut on the stuff. It embraces the hollow mandrel, which in turn incloses the graduated shank. The tube is adjusted on the shank so as to determine the length of the spoke-tenon, and is secured by a temper-screw.

**Ten'on-ing-chis'el.** A double-blade chisel which makes two cuts, leaving a middle piece which forms a tenon. The two chisels are connected by steady pins and a key to the stock, and are adjusted into exact parallelism by two right and left handed set-screws.

**Ten'on-ing-ma-chine'.** (*Wood-working.*) A machine for cutting timber to leave a tenon. It may

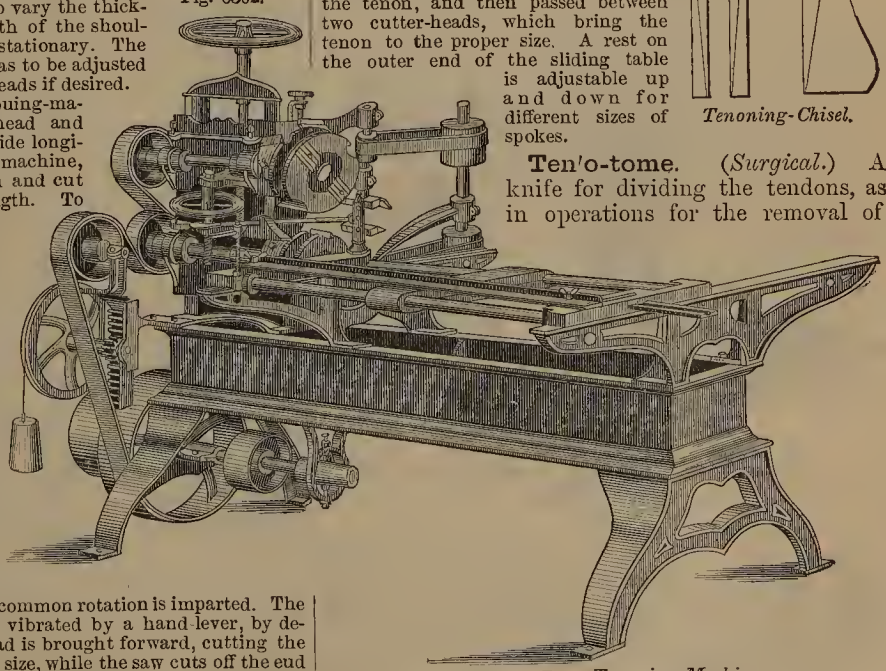
Fig. 6298.



*Tenons.*

have either a hollow auger, which cuts the stuff away down to the shoulder (see TENON-AUGER); or it may be of the nature of a planing-machine, which, by revolving cutters, removes the stuff from the side, giving the *shoulders* at the sides, and the *relish*, if any (see TENON); or it may be of the nature of a mortising-machine, where chisels cut away the stuff and leave a projecting piece, which constitutes the tenon (see MORTISING-MACHINE).

Fig. 6302.



*Sash and Door Tenoning-Machine.*

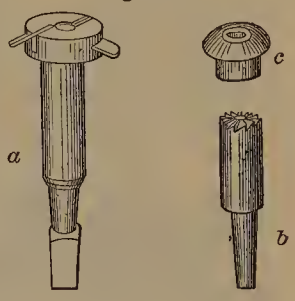
Fig. 6303 is a machine particularly designed for sash and door work. It is provided with single cutter-heads and double copes. Both cutter-heads are raised and lowered by a screw and band wheel to each, and are readily adjustable, to vary the thickness of the tenon or the depth of the shoulder, the carriage remaining stationary. The coping heads are so arranged as to be adjusted independently of the cutter-heads if desired.

Fig. 6303 is a blind-slat tenoning-machine. The rotary cutter-head and saw-carriers are arranged to slide longitudinally on the bed of the machine, so as to simultaneously tenon and cut off slats of any required length. To provide for this, the main driving-pulleys are made of an elongated form, permitting a considerable range to the belts.

The machine, Fig. 6304, is designed for forming oval tenons on the ends of spokes, obviating the necessity of wedging when the rim is put on. The wheel is held by two chucks which receive the ends of the hubs, and the spoke being operated on is seized by two geared clamps which open and close simultaneously, presenting its end to the action of the cutters and a saw, which are carried on a spindle placed eccentrically to a gear-wheel, by which their common rotation is imparted. The upper part of the machine is vibrated by a hand-lever, by depressing which the cutter-head is brought forward, cutting the oval, which may be varied in size, while the saw cuts off the end of the spoke.

Fig. 6305 is a machine for cutting mortises and tenons on the ends of heavy framing-timbers; especially the sill-pieces of railway-car frames. The cutter-heads are fitted to a horizontal spindle running in self-oiling bearings, fixed to a traveling head, which is moved vertically by means of a rack, pinion, and hand-wheel. Tenons may be worked on each end of timbers without turning them around, by passing them along lengthwise across the gap, previously raising the cutters out of the way by turning the hand-wheel.

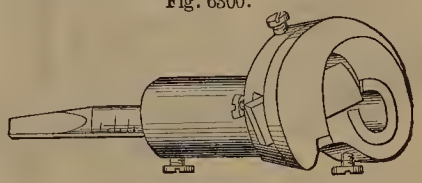
Fig. 6299.




*Tenon Auger and Bur.*

**Ten'on-saw.** A thin saw with a thicker metallic backing; used for fine work, such as sawing tenons, dovetails, miters for joints, etc.

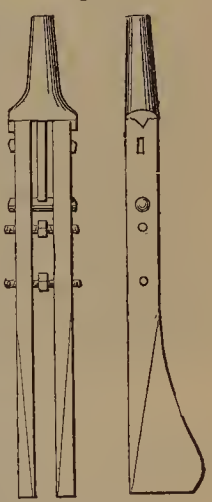
Fig. 6300.



*Stearns's Hollow Auger for Spokes.*

Some varieties are known as *sash*, *carcase*, and *dovetail* saws. The tenon-saw has 8 teeth to the inch; the carcase-saw, 11 teeth to the inch; the sash-saw, 13 teeth to the inch; the dovetail-saw, 15 teeth to the inch.

Fig. 6301.



*Tenoning-Chisel.*

**Ten'on-tru'ing Machine'.** (*Wood-working.*) A machine for truing or sizing the tenons of spokes and cutting the tenons to the desired length at the same operation. It has an upright spindle with two cutter-heads, the upper one being adjustable to vary the thickness of the tenons.

The spoke is laid on a small sliding-table, pushed forward to a circular saw, which cuts off the end of the tenon, and then passed between two cutter-heads, which bring the tenon to the proper size. A rest on the outer end of the sliding table is adjustable up and down for different sizes of spokes.

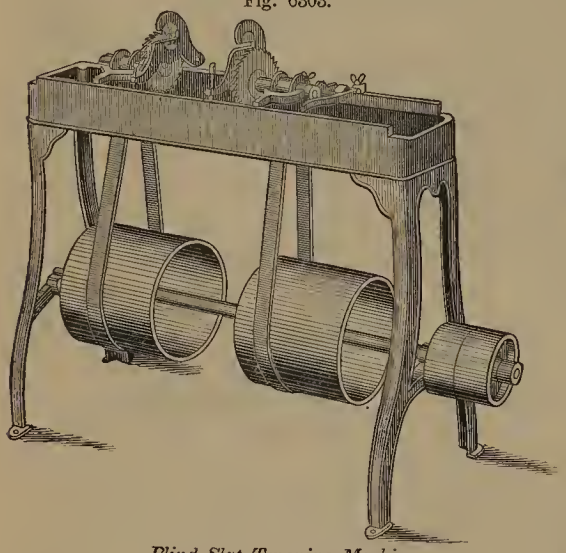
**Ten'o-tome.** (*Surgical.*) A knife for dividing the tendons, as in operations for the removal of

*loxarthrus*, or deviation of the joints, as in club-foot.

*a*, pocket-tenotome.
*b c d e*, tenotomes of various shapes, to suit special needs.

**Ten'sile Strength.** The cohesive power by which a material resists an attempt to pull it apart in the direction of its fibers. This bears no relation to its capacity for resisting compression ; cast-iron, for

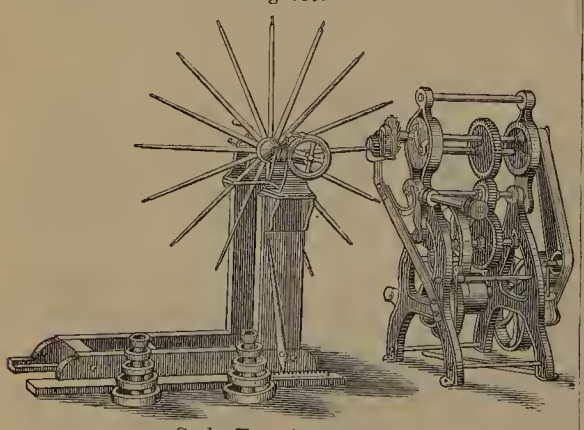
Fig. 6303.



*Blind-Slat Tenoning-Machine.*

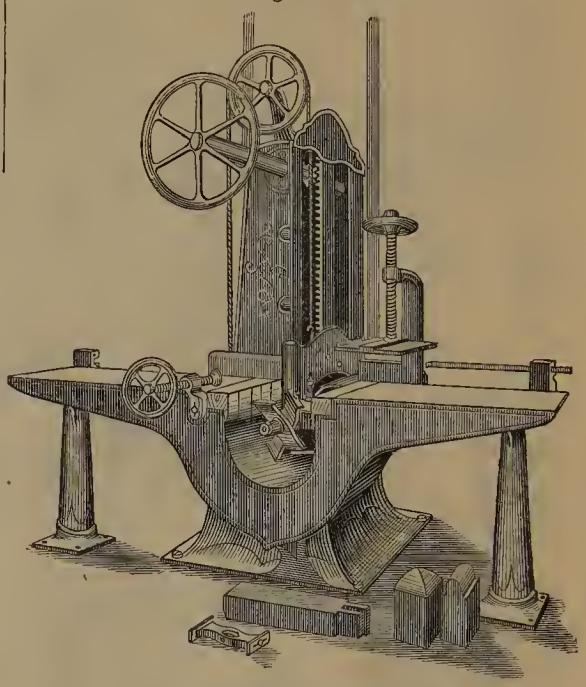
example, which possesses a comparatively low tensile strength, say 30,000 pounds, requires a force of 100,000 pounds or more to the square inch to crush it; while good bar-iron, having nearly double the tensile strength, is crushed by a force of 40,000 pounds to the square inch. The difference is still more marked in the case of stone and similar materials. The table appended gives the usually accepted data. The experiments of General Rodman, Ordnance Manual, 1861, give generally much higher tenacities to the different specimens of wood tested by him. See TESTING-MACHINE.

Fig. 6304.



*Spoke-Tenoning Machine.*

Fig. 6305.



*Fay's Gap-Bed Tenoning-Machine.*

*Weight or Power required to tear asunder one Square Inch.*

METALS.

| | Lbs. | | Lbs. |
|---|---|---|---|
| Copper, wrought | 34,000 | Iron, Clyde, No. 1 | 16,125 |
| Copper, rolled | 36,000 | Iron, Clyde, No. 3 | 23,468 |
| Copper, cast, American | 24,250 | Iron, Calder, No. 1 | 13,735 |
| Copper, wire | 61,200 | Iron, Stirling, mean | 25,764 |
| Copper, bolt | 36,800 | Iron, mean of American | 31,829 |
| Iron, cast, Low Moor, No. 2 | 14,076 | Iron, mean of English | 19,484 |

| | Lbs. | | Lbs. |
|---|---|---|---|
| Iron, Greenwood, American | 45,970 | Steel, razor | 150,000 |
| Iron, gun-metal, mean | 37,232 | Tin, cast, block | 5,000 |
| Iron, wrought wire | 103,000 | Tin, Bauca | 2,122 |
| Iron, best Swedish bar | 72,000 | Zinc | 3,500 |
| Iron, Russian bar | 59,500 | Zinc, sheet | 16,000 |
| Iron, English bar | 56,000 | Brick, well burned | 750 |
| Iron, rivets, American | 53,300 | Brick, fire | 65 |
| Iron, bolts | 52,250 | Brick, inferior | 290 to 100 |
| Iron, hammered | 53,913 | Cement, blue stone | 77 |
| Iron, mean of English | 53,900 | Cement, hydraulic | 234 |
| Iron, rivets, English | 65,000 | Cement, Harwich | 30 |
| Iron, crank shaft | 44,750 | Cement, Portland, 6 months | 414 |
| Iron, turnings | 55,800 | Cement, Sheppy | 24 |
| Iron, plates, boiler, American | 48,000 to 62,000 | Cement, Portland 1, sand 3 | 380 |
| Iron, plates, mean, English | 51,000 | Chalk | 118 |
| Iron, plates, lengthwise | 53,800 | Glass, crown | 2,346 |
| Iron, plates, crosswise | 48,800 | Gutta-percha | 3,500 |
| Iron, inferior, bar | 30,000 | Hydraulic lime | 140 |
| Iron, wire, American | 73,600 | Hydraulic lime mortar | 140 |
| Iron, wire, American, 16 diameter | 80,000 | Ivory | 16,000 |
| Iron, scrap | 53,400 | Leather belts | 330 |
| Lead, cast | 1,800 | Limestone | 670 to 2,800 |
| Lead, milled | 3,320 | Marble, Italian | 5,200 |
| Lead, wire | 2,580 | Marble, white | 9,000 |
| Platinum, wire | 53,000 | Mortar, 12 years old | 60 |
| Silver, cast | 40,000 | Plaster of Paris | 72 |
| Steel, cast, maximum | 142,000 | Rope, Manilla | 9,000 |
| Steel, cast, mean | 88,657 | Rope, hemp, tarred | 15,000 |
| Steel, blistered, soft | 133,000 to 104,000 | Rope, wire | 37,000 |
| Steel, shear | 124,000 | Sandstone, fine grain | 200 |
| Steel, blister | 133,000 | Slate | 12,000 |
| Steel, puddled, extreme | 173,817 | Stone, Bath | 352 |
| Steel, puddled or semi-iron | 121,408 | Stone, Craigleth | 400 |
| Steel, plates, lengthwise | 96,300 | Stone, Hailes | 360 |
| Steel, plates, crosswise | 93,700 | Stone, Portland | 857 to 1,000 |
| | | Whalebone | 7,600 |

COMPOSITIONS.

| | Lbs. | | Lbs. |
|---|---|---|---|
| Gold 5, copper 1 | 50,000 | Copper 8, tin 1, gun-metal | 30,000 |
| Brass | 42,000 | Copper 8, tin 1, small bars | 50,000 |
| Brass, yellow | 18,000 | Tin 10, antimony 1 | 11,000 |
| Bronze, least | 17,698 | Yellow metal | 48,700 |
| Bronze, greatest | 56,788 | | |
| Copper 10, tin 1 | 32,000 | | |

WOODS.

| | Lbs. | | Lbs. |
|---|---|---|---|
| Ash | 14,000 | Cypress | 6,000 |
| Bay | 14,000 | Deal, Christiana | 12,400 |
| Beech | 11,500 | Elm | 13,400 |
| Box | 20,000 | Lance | 23,000 |
| Cedar | 11,400 | Lignumvitæ | 11,800 |
| Chestnut, sweet | 10,500 | Locust | 20,500 |

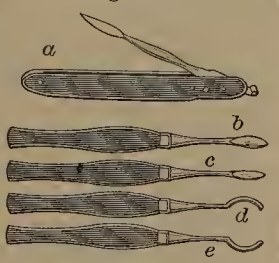
| | Lbs. | | Lbs. |
|---|---|---|---|
| Mahogany | 21,000 | Pine, pitch | 12,000 |
| Mahogany, Spanish | 12,000 | Pine, larch | 9,500 |
| Mahogany, Spanish | 8,000 | Pine, American white | 11,800 |
| Maple | 10,500 | Poplar | 7,000 |
| Oak, American white | 11,500 | Spruce, white | 10,290 |
| Oak, English | 10,000 | Sycamore | 13,000 |
| Oak, seasoned | 13,600 | Teak | 14,000 |
| Oak, African | 14,500 | Walnut | 7,800 |
| Pear | 9,800 | Willow | 13,000 |

**Ten'sion.** 1. (*Telegraphy.*) Power of overcoming resistance.

2. (*Mechanics.*) The lengthwise straining force on a member of a truss or frame.

3. (*Sewing-machine.*) A pressure upon the thread to prevent its running too easily from the spool. By adjustment of the pressure at the tension device, the required tightness of stitch is obtained.

Fig. 6307.




Tenotomes.

Fig. 6306.

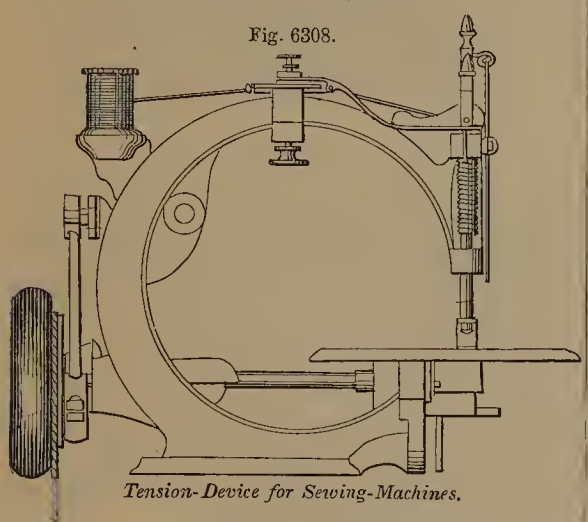
Tenon-Saw.

In Fig. 6308, the thread passes between two plates secured to the pressure-foot arm, one of which plates is operated by means of a spring acting as a lever, by which the tension is rendered self-adjusting, according to the thickness of the cloth.

There are many other kinds of *tensions*, in different machines. See list, Division F, section 25, page 2112.

Fig. 6309 shows the Willcox and Gibbs automatic tension, a mechanism to hold the thread firmly, so that none can be drawn through until at a fixed point, and then suddenly release it, allowing whatever is required to be freely drawn through. The amount of thread taken at each stitch being of course just what is required to inclose the goods being taken out of the slack

Fig. 6308.



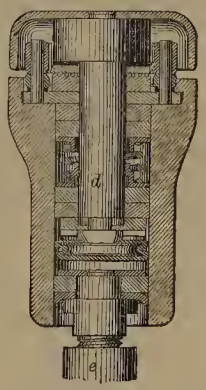
*Tension-Device for Sewing-Machines.*

thread formed by the descent of the needle-bar take-up, it follows that when the take-up rises and the looper continues to revolve, a point is reached when some more thread must be allowed to escape through the tension, or the thread will be broken. At this time the loop cast off from the looper being drawn up to the under side of the material, the tension opens, and just enough thread is taken to make good the loss.

The automatic tension-device, shown above the actual size in Fig. 6309, and in situ in Fig. 4865, is placed in the standard of the machine, and the thread passing from the spool to the *pull-off* is then led past two pins and between two disk surfaces, one of which is ridged to make the hite upon the thread more effective. The spiral spring shown around the stem *d* is the agent in this grasp of the thread, but at a certain part of the stroke, as above explained, the rod *e* is lifted by an eccentric, and by this positive motion the stem *d* and upper disk are lifted, allowing the thread to be pulled through by the motion of the needle-arm. This elegant device is worthy of a more detailed description.

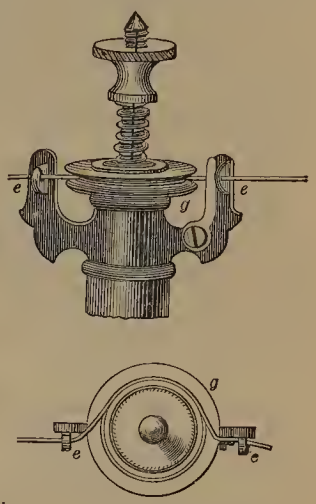
Fig. 6310 shows the W. G. Wilson device for controlling the degree of tightness of the thread of a sewing-machine. The upper thread and the shuttle-thread should have the same tension in a lock-stitch machine, so as to pull the bights of the threads into the middle of the fabric. The under-thread tension is regulated by springs or pins on the shuttle, or by holes in it,

Fig. 6309.




*Willcox and Gibbs Automatic Tension.*

Fig. 6310.




*Wilson Tension.*

and, in revolving-hook machines, by other means. The upper thread is usually passed against two standards *e e*, between which it is wrapped around a grooved sheave *g*, and its tightness is controlled by the pad, spring, and tension nut, which offers more or less impediment to the rotation of the sheave.

**Ten'sion-bridge.** A bridge constructed on the principle of the bow, the arch supporting the track by means of tension-rods, and the string acting as a tie. See BOWSTRING-BRIDGE.

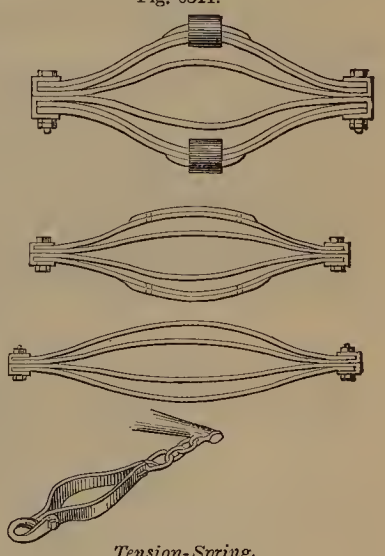
The name may also be applied to a bridge much advocated some years back, for short spans, in which long wooden strips were anchored at each end, and strained as nearly level as possible.

The tension principle abounds in the lower longitudinal members of all truss-girders.

**Ten'sion-rod.** A *stay* or *tie-rod* in a truss or structure, which connects opposite parts and prevents their spreading asunder.

**Tension-spring.** A spring for wagons, railway-carriages, etc. The inner leaves, and, in some cases, the outer ones, are free in the center, so as to elongate independently under pressure. The outer leaves may be of any suitable form, so that they impart a tensile strain to the inner ones, which are preferably of *cyma reversa* curvature. Under heavy strains the inner leaves elongate, so as to nearly form cords to the arc of the outer leaves; this limits the inward flexibility of the spring.

Fig. 6311.



*Tension-Spring.*

**Tent.** 1. A portable shelter of fabric or other flexible material. Skins have been used for the purpose among barbarous tribes from time immemorial.

The tent is the original of the most graceful of all styles of

architecture, — the Chinese. No plane-surfaced roof, whatever its pitch, can vie in beauty with that which simulates the covering of a tent or pavilion.

Its form permits an amount and kind of graceful ornamentation, checker-work, stripes, barge-boards, and scalloped bordering, which become it, and are mere arbitrary and extraneous ornaments to the more formal styles.

Tents form an important part of the equipment of an army in the field, and much ingenuity has been exerted in endeavoring to secure the maximum of accommodation and comfort with a minimum of weight and space. See ACCOUTERMENTS, Fig. 19. They are known as

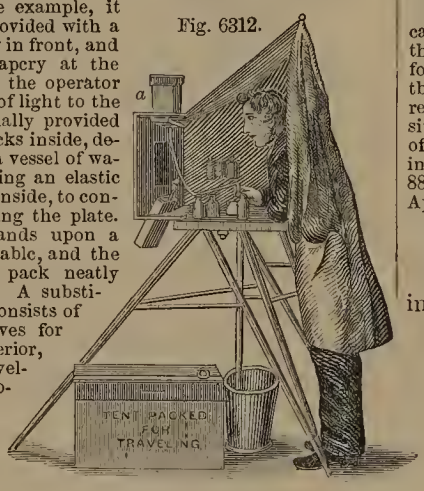
| | | |
|---|---|---|
| Bell-tent, | Marquee, | Sibley-tent, |
| Hospital-tent, | Shelter-tent, | Wall-tent, etc. |

The tent of Achilles was a wooden hut covered with reeds. Such were sometimes used by the Romans in winter. On the Trajan and Antonine columns are four-square tents with slanting roofs, and also conical tents. They were sometimes of leather, usually of cloth. Nero had an octagon tent of great beauty. The Oriental tents were of silk, and gorgeously furnished. That of Attila was very spacious and magnificent. Alexander placed 200 persons in one pavilion.

2. (*Photography.*) An instrument for field-photography; a substitute for the usual dark room.

As shown in the example, it consists of a box provided with a yellow glass window in front, and furnished with drapery at the back, so as to cover the operator and prevent access of light to the interior. It is usually provided with shelves and racks inside, developing-tray, and a vessel of water *a* overhead, having an elastic tube passing to the inside, to convey water for washing the plate. The instrument stands upon a tripod or skeleton-table, and the whole is made to pack neatly for transportation. A substitute for the tent consists of arm-holes and sleeves for reaching the interior, the progress of development being observed through a yellow window.

Fig. 6312.




*Photographer's Tent.*

3. (*Surgical.*) A roll of lint, sponge, etc., of cylindrical or conical shape, introduced into an ulcer or wound to keep the external portion open and induce it to heal from the bottom.

Sponge-tent is made by dipping the sponge into melted wax plaster and pressing it till cold between two iron plates. It is then cut into pieces.

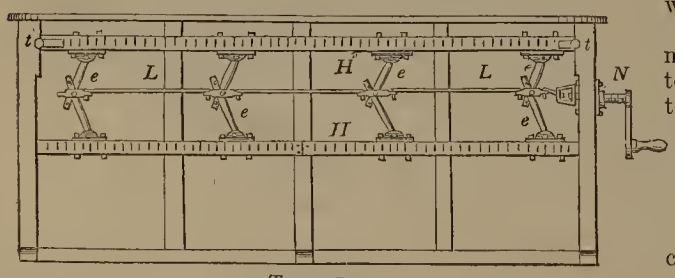
Paper pulp, to which grated sponge has been added, is used for making a paper which may be rolled up to form a tent.

**Ten-ta'tion.** A mode of operating or adjusting by essay, trial, or experiment, as in

1. (*Locksmithing.*) A mode of picking locks in which the bolt is pressed backward constantly, and the tumblers released one by one from the stud.

2. (*Compass-adjusting.*) Professor Airy's mode of adjusting compasses in iron ships, in which boxes of iron chain and magnets are experimentally placed and shifted in position until the disturbing influence of the iron hull is neutralized. See page 1398.

Fig. 6313.




*Tenter-Bar.*

**Ten'ter.** 1. A frame used to stretch pieces of cloth, to make them set even and square. The selvedges of the cloth are attached to the frame by sharp hooked nails, called *tenter-hooks.*

2. A drying-room.

**Ten'ter-bar.** A device for stretching cloth.

In the apparatus, Fig. 6313, the cloth is attached by hooks to bars *H H'*, which are then drawn apart equally throughout their length by a succession of toggle-levers *e e* actuated by a crank-screw *N* and rods *L L*, which connect the hinging-joints of the toggles.

**Ten'ter-hook.** One of a set of hooks arranged on the inside margin of a frame and used in stretching cloth, the margin of which is held fast by the hooks.

**Ten'ter-ing-ma-chine'.** A machine for stretching fabrics.

In one form of the machine, combinations of adjustable oblique traveling selvedge-feeding and carrying devices are used, which, in some cases, operate in connection with endless belts, bands, or cords arranged to hold the selvedges of the fabric in between them and the carrying-devices; the intermediate portion or body of the fabric is run over a divided longitudinally expanding and contracting friction-frame or drag arranged between the selvedge carrying and stretching devices.

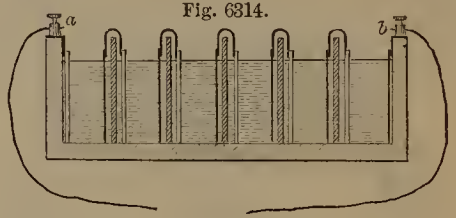
Another machine has an arrangement of separate selvedge carrying, stretching, and feeding devices on opposite sides of the machine, driven in a positive manner, with facility not only for driving said devices on one side of the machine and not on the other, but of positively driving them at different velocities relatively with each other, to adjust the stretch or feed on opposite sides, as required. A roller on the delivery side at the foot of the chains stretches the fabric in its passage from the stretching-devices to the first drying-cylinder. See Palmer's patents, 88,504, March 30, 1869; 148,082, March 3, 1874; and 161,896, April 13, 1875.

**Tent'ure.** Paper-hangings; wall-paper.

**Term.** (*Shipwrighting.*) See TERM-PIECE.

**Ter'mi-nal.** (*Electro-magnetism.*) The clamping-screw at each end of a voltaic battery, used for

Fig. 6314.




*Battery.*

connecting it with the wires which complete the circuit. One terminal *b* is at the copper or *negative pole*, and the other *a* at the zinc or *positive pole*. Their connection by wire starts the battery into action.

**Ter'mi-ni.** (*Architecture.*) Busts or figures of the upper portion of the human body, terminating in a downwardly tapering block; employed as pillars, balusters, or detached ornaments for niches. Non-detached ornaments for support may be found under ATLANTES; CARYATIDES; PERSIANS; TELAMONES; etc.

**Term-piece.** (*Shipbuilding.*) One of the pieces of carved work extending from the end of the taff-rail to the foot-rail of the baleony.

**Terne-plate.** Thin iron plate coated with an alloy of tin and lead.

**Ter'ra-al'ba.** Literally, *white earth.* Armenian bole; pipe-clay. Used as an adulteration of confectionery, for adding to paper to increase its weight, and for other purposes. The name is also applied to other materials similarly used: as, for instance, calcined or powdered gypsum; calcined, powdered, and floated sulphate of barytes.

**Ter'ra-cot'ta.** (Fr. *terre cuite*, baked clay.) A compound of pure clay, fine-grained, colorless sand or calcined flints, and pulverized potsherds, is molded, dried in the air, and baked in a kiln. It is especially used for architectural decorations, figures, vases, etc.

Blanchard's terra-cotta (Exposition, London, 1851) was a composition of white pipe-clay, crushed potsherds, calcined flint, flour glass, and white sand, well compounded. The molded articles were burned at a high temperature.

A good article of terra-cotta is more durable when weather-exposed than most stone.

**Ter'ras-es.** (*Masonry.*) Hollow defects in marble or fissures filled with nodules of other substances. The hole, being cleaned out, is filled with marble dust and mastic of the same color. See BADIGEON, page 207.

**Ter'ra-sphere.** A term for the TELLURIUM (which see).

**Terre'-plein.** (*Fortification.*) The upper part of the rampart which remains after constructing the parapet. See BASTION.

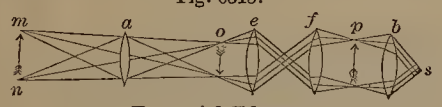
**Ter-res'tri-al Eye-piece.** (*Optics.*) An eye-piece with three or four lenses, so arranged as to present the image viewed in an erect position. An *erecting eye-piece.* See TERRESTRIAL TELESCOPE.

**Ter-res'tri-al Globe.** A spherical map representing the land, seas, etc., of the world. In contradistinction to the *celestial* globe, on which are depicted the constellations.

**Ter-res'tri-al Tel'e-scope.** A telescope differing from the *astronomical refracting* in having two additional lenses, so as to restore the inverted image to an erect position.

The focal lengths of the additional lenses *f b* are usually the same as that of the eye-glass. The two pencils of rays proceeding from the points *m* and *n* cross each other in the anterior

Fig. 6315.




*Terrestrial Telescope.*

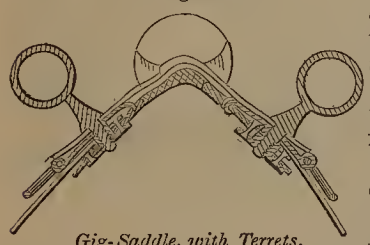
focus of the second lens *f*, and, falling parallel on that lens, form in its principal focus an inverted image of *o*, and consequently an erect image of the object *m n*.

This image *p* is seen by the eye at *s* through the lens *b*, as the rays diverging from *p* in the focus of *b* enter the eye in parallel pencils.

When the first three lenses are equal, the magnifying-power is the same as that of the astronomical telescope, whose object and eye glasses are the same as *a e*. See TELESCOPE.

Rheita was the first to employ the combination of three lenses, known as the *terrestrial* telescope. Scheiner, in 1630, had used a combination of two convex lenses, the image being inverted; to this he afterward added two other glasses, which again reversed the images, making them appear in their natural position.

Fig. 6316.



*Gig-Saddle, with Terrets.*

**Ter'ret.** (*Saddlery.*) A ring attached to the pad or saddle and hames of harness, through which the driving-reins pass.

**Ter'ri-er.** An *auger.* A *wimble.*

**Ter'ro-met'al.** A composition of several clays, possessing, when baked, peculiar hardness, introduced by Mr. Peake, a potter, of Burslem, England.

It is principally employed for making tiles of various kinds.

**Ter'ry.** (*Rope-making.*) An open reel.

**Ter'ry-fab'ric.** (*Weaving.*) (Fr. *tirer*, to draw, to draw out.) A pile fabric, such as plush or velvet; probably from the *drawing out* of the wires over which the warp is laid to make the series of loops seen in Brussels carpet or uncut velvet.

In some looms for weaving pile fabrics, mechanism is employed for actuating the wires, the *terry* loop forming the pile being obtained by inserting wires in a shed formed between the body warp and pile warp, which wires are woven in the fabric, to be again withdrawn in succession when a sufficient number of wires have been woven in the fabric to secure the loops or woven pile against the strain produced in the process of weaving.

**Ter'ry-vel'vet.** A silk plush, or ribbed velvet.

**Tes'sel-at-ed Pave'ment.** A pavement composed of square dies or tesseræ made of baked clay or stone, generally of various colors, and forming regular figures. It was employed by the ancients, particularly by the Romans, whose remains furnish the greatest number of existing specimens of ancient art in this line, and is much in vogue in the East, particularly at Damascus.

A pavement of this character, made of cubes of red, blue, black, and white marble, is mentioned in Esther i. 6.

Colored glass cubes were substituted for marble, and were common in the time of Augustus.

**Tes'sel-at-ed Tile.** Tile made of clay of a particular color, or mixed with coloring matters and formed into flat cakes by cutting or pressing, and used for making a tesselated pavement.

**Tes'se-ræ.** Colored tiles or bricks, usually cubical, laid in patterns, as a mosaic pavement. See Adam Clark on Revelation ii. 17. See also ABACUS.

**Test.** 1. (*Metallurgy.*) *a.* A *cupel.*

*b.* A cupeling-hearth used in a refining-furnace where lead is separated from silver on a large scale. The *test* is an oval iron frame containing a basin-shaped mass of powdered bone-ash, which is brought to a consistence by a solution of pearlash. The *test* is fixed as a cupeling-hearth in the reverberatory furnace, and is subjected to a blast from a tuyere, which removes the floating oxide of silver and furnishes oxygen for its elimination from the alloy under treatment.

Pattinson's process has nearly superseded the plan just described. See SILVER FROM LEAD, EXTRACTING.

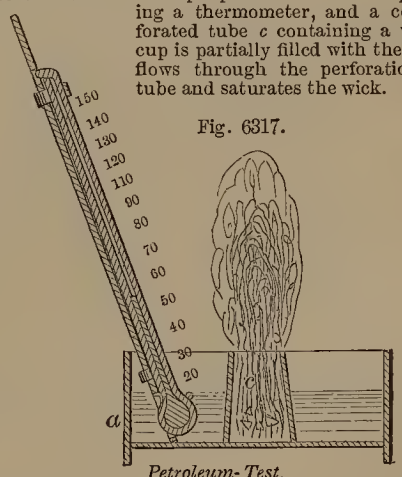
2. The proof of condition of a sirup, which is generally a matter of practice with the sugar-boiler, but has been reduced to a system by Payen. See PROOF.

3. In chemistry, a body which is used to detect the presence of another body in solution, indicating the said presence by a peculiar behavior, or by producing a specific effect. The behavior may be a change of color, as with litmus or turmeric paper. The effect may be a change in the solution as to color, limpidity, evolution of gas, precipitation, heat, congelation, etc.

4. An apparatus for proving petroleum and similar hydrocarbon oils by ascertaining the temperature at which they evolve explosive vapors.

Fig. 6317 consists of a cup *a* provided with a loop for holding a thermometer, and a central perforated tube *c* containing a wick. The cup is partially filled with the oil, which flows through the perforations in the tube and saturates the wick. The latter,

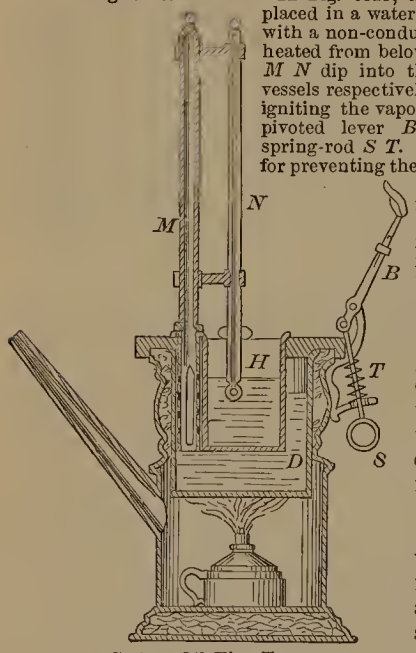
Fig. 6317.




*Petroleum-Test.*

being ignited, heats the oil to the vaporizing point and sets fire to the vapor.

Fig. 6318.




*Carbon-Oil Fire-Tester.*

In Fig. 6318, the oil-vessel *H* is placed in a water-bath *D* provided with a non-conducting jacket, and heated from below. Thermometers *M N* dip into the water and oil vessels respectively. The brand for igniting the vapor is carried by a pivoted lever *B* operated by a spring-rod *S T*. A cap is provided for preventing the vapor from being disturbed by currents of air, and a spigot for ensuring a uniformity in the level of the water and oil.

**Test-cock.** (*Steam-engine.*) A small cock fitted to the top or bottom of a cylinder for clearing it of water. It is generally constructed with a ball or reverse valve at its mouth, so as to allow of being kept open without the entrance of air, when there is a vacuum on the side of the piston with which it communicates. A *cylinder cock.*

**Tes'ter.** 1. The square canopy of a four-post bedstead.

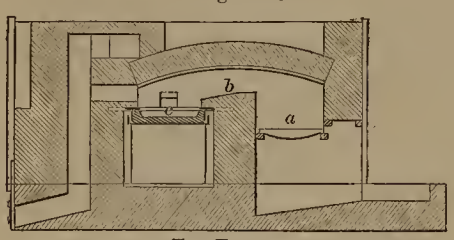
2. The canopy over a pulpit or tomb.

**Tes'tes-sup-port'er.** A suspensory bandage for the scrotum.

**Test-fur'nace.** (*Metallurgy.*) One form of refining furnace for treating argentiferous alloy, such as that of lead rich in silver.

It is of the reverberatory kind, *a* being the fire-grate, *b* the fire-bridge; *c* is the cupel or test, consisting of an oval ring of iron provided with cross-bars, into which a bone-ash mixed with water containing a small proportion of pearlash is packed, so as to form a reservoir for the molten metal. The test, when packed, is secured to an iron ring built into the masonry, and a low heat is applied to expel the moisture; this is afterward increased until the test becomes heated to a cherry red, when the argentiferous lead previously melted in another furnace is poured in. This soon becomes covered with a grayish dross, and on increasing the heat litharge begins to form. The blast is now turned on, sweeping the litharge from the surface of the alloy and over the breast, where it is received in a proper vessel. As the metal decreases in volume, more is added, and the operation continued until that remaining at the bottom of the test is sufficiently rich to be drawn off; unless this be done at the proper point, a proportion of the silver is carried off with the litharge. When all the argentiferous alloy has been thus treated, it is again subjected to cupellation in the same or a similar furnace, by which the lead is converted into litharge, the silver remaining at the bottom of the cupel, which is then allowed to partially cool, is removed from the furnace, and the plate of silver detached. See ALLOY; AMALGAMATION; ASSAY; PARTING; CUPEL.

Fig. 6319.




*Test-Furnace.*

**Test-glass.** A glass vessel of conical or cylindrical form, having a foot and sometimes a beak; used for holding chemical solutions.

Fig. 6320.

*Test-Glasses.*

**Test'ing-gage.** In Fig. 6321, *a* is an instrument for ascertaining the pressure of gas in soda-water bottles, in order to check the work of the bottlers or test the soda-water of different makers.

Fig. 6321.

*Testing-Gage.*

It consists of a bent mercurial gage with graduated scale, having a tube with cock and screw-point at its lower end, which is inserted through the cork; on the cock being turned, the gas in the bottle *b* operates on the mercurial column in the bent tube. The ordinary pressure in bottles of soda-water is found to be from 40 to 60 lbs. per square inch, seldom rising to 70 lbs. See also TEST-PUMP.

**Test'ing-ma-chine'.** *a.* One for determining the strength of materials with strains of different kinds, tensile, transverse, and what not.

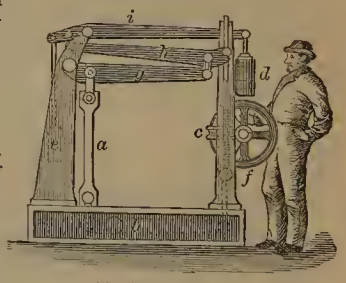
*b.* A machine for determining the lubricity of oils and other materials used to avoid friction between moving parts.

*c.* A machine for testing the power of motors. See DYNAMOMETER; also *infra.*

The machine, Fig. 6322, is designed for testing the tensile strength of metals. The rod *a* to be tested is cut to one square inch in section, and is held between clamps attached respectively to the levers *b g*. The lever *b* is acted on by a worm-wheel *c* and worm operated by a hand-wheel *f*, bringing the tensile strain upon the scale-beam levers *g h i*; to the long arm of the latter weights *d* are applied until the bar *a* is ruptured or the required testing-strain is reached. *e* is a counterbalance-weight for the levers *g h i*.

In Fig. 6323, *A* is an end and *B* a side elevation of a testing-machine designed by Major Wade for the United States Ordnance Department. The lever *a* to which the power is applied has its fulcrum at *a'*, supported by an interior frame *b* attached to the screw *c*, which passes through the axis of the bevel-wheel *d* above. The knife-edge *e*, from which the weights are suspended, is 72 inches, and the knife-edge *f* is 3.6 inches, from the fulcrum, or in the proportion of 20 to 1. From the latter is suspended the stirrup *g*, which receives the knife-edge of the long arm of the lever *h*, fulcrumed at *h'*, 60 inches distant, and supporting the knife-edge of the stirrup *i* at a point 6 inches distant from the fulcrum. A force applied at *e* is thus multiplied 200 times at the latter point. By means of a crank *j* having a pinion gearing with the wheel *k*, the axis of which carries a bevel-pinion mashing with the wheel *d*, the screw *c* is raised, lifting the frame *b*, and with it the lever *a*. The long arm of this lever passes through a slotted guide *l*, which is simultaneously lifted by the turning of the rod *m*, which has a pinion at each end mashing with racks on the frame *b* and guide *l* respectively. The object of these arrangements is to keep the lever always in a very nearly horizontal position.

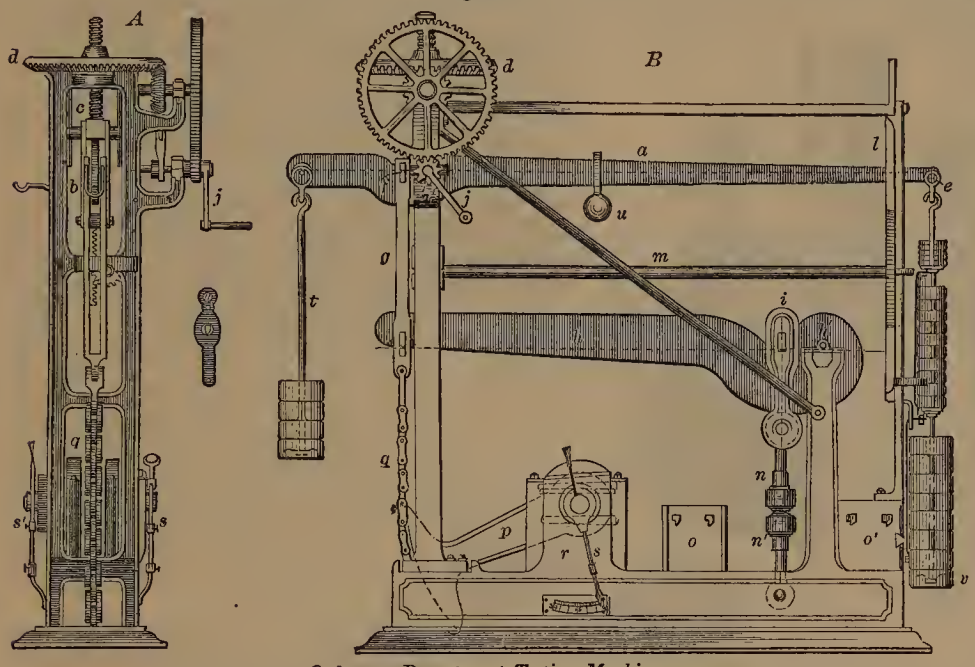
Fig. 6322.




*Testing-Machine.*

*n n'* are the devices for holding a bar which is to be tested by extension; these may be replaced by suitable devices for exerting a crushing force, and others for exerting a transverse upward pressure on a bar when drawn up against steel cross-bars placed transversely in the hollow blocks *o o'*, cast with the bed-plate of the machine. *p* is the torsion-lever connected by a chain *q* with the stirrup *g*. In experiments in torsion the lever *a* is elevated bodily by the screw *c* through the medium of the crank *j* and its gearing, the bar to be tested being firmly held by the pedestal *r* at one end, and keyed to the journal of the torsion-lever at the other. The lever *h* is not in this case

Fig. 6323.




*Ordnance Department Testing-Machine.*

brought into action. There is an index *s s'* on each side for indicating the degree of torsion, which, as the bar has a limited amount of play in its fastenings, is determined by the difference of the indexes.

The weights usually employed are of ½ pound, 5 pounds, and 25 pounds, representing strains of 100, 1,000, and 5,000 pounds.

The rod *t* with its platform and weights is used for adjusting the equilibrium of the machine, and also for counterbalancing the platform *v* suspended from the long arm of the lever when tensions of less than 5,000 pounds are being investigated. *u* is a movable weight for equilibriating the holding devices suspended from the stirrup *i*.

The apparatus (Fig. 6324) invented by Professor R. H. Thurston, of the Stevens Institute of Technology, Hoboken, N. J., is designed for testing and automatically registering variations in strength, elasticity, and ductility of materials; also showing the absolute tensional or torsional strength.

The framework *a a'* supports two arms *b c* turning upon independent axes in the same line. The arm *b* carries a weight *d*, and the arm *c* a handle *e* by which it is moved. To the frame is attached a guide-curve *f*, so formed that its ordinates are precisely proportional to the strain exerted by the arm *b* on the material to be tested. This arm also carries a pencil-holder containing a pencil which is pushed outward by the curve *f* as the arm is deflected from the perpendicular. A table *g*, to which the record paper is fastened, is attached to the arm *c*. A pointer *j* traversing the arc *k* serves as a check upon the record of maximum strength made by the pencil on the paper.

The axes of the arms *b c* are alike (*B*), and have rectangular recesses *l* designed to receive the ends of the pieces of material when experimenting with torsional strains; the ends of the pieces are made square, and are turned circular at the center, as shown at *C D*; one end is accurately fitted into the recess on the axis *b'*, and the other into the corresponding recess in *c'*, and force is applied to the arm *c*, which is transmitted through the piece being tested to the weighted arm *b*. The normal position of this arm is vertical, but under the influence of the applied pressure it rises, the weight *d* exerting a greater leverage as it rises; the guide-curve *f* is therefore so shaped as to cause the pencil to move equal distances with equal increments of force.

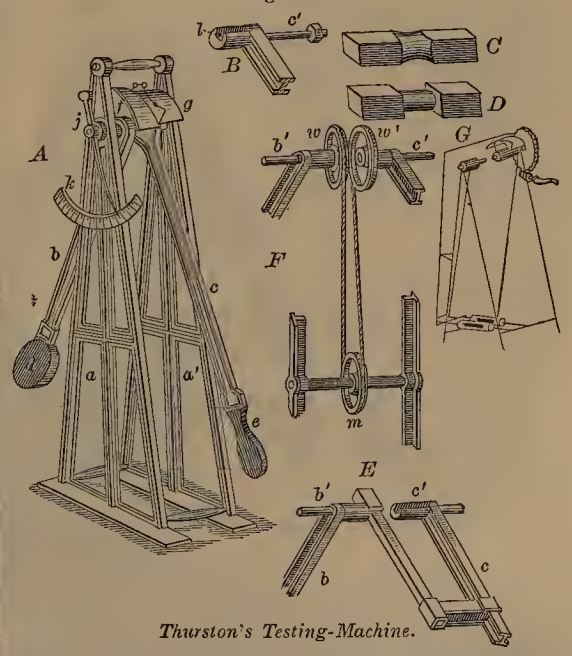
If the material to be tested were devoid of elasticity, the amount of movement of the arms *b c* would be exactly equal, and the pencil would describe a straight line; but as all materials yield more or less, the arm *b* will have less angular movement than *c* after the point is reached at which the fibers of the test-piece begin to change their relative positions, and the difference of their angular movements affords a measure of the distortion produced in the specimen, which is recorded by the curve traced by the pencil.

The paper may be ruled previous to being placed on the table *g*, according to a scale previously determined from the total movement of which the pencil is capable and the known powers required to lift the weight *d* to any angle between the vertical and horizontal; in this case the base line of the diagram is placed parallel to the planes in which the two arms move; the pencil is placed at the intersection of one of the lines parallel thereto with one of the other series, which are vertical to it; these serve respectively as the ordinates and abscisses by which the curve showing the behavior of the material being tested is measured. If the paper be not previously ruled, a line drawn between the points at which the pencil was first applied, and at which it rested when the separation of the piece was effected, serves as a basis for constructing the coordinates, their origin being reckoned from the first point.

The record thus made is a curve, whose length depends on the amount to which the specimen was twisted before giving way entirely, and its depth shows the maximum force exerted to produce this result. The position of the pencil momentarily changes with each variation in the resistance of the material, and it is at the same time carried along on the periphery of the recording cylinder to a distance proportional to the amount of distortion or the total angle of torsion. As the applied force increases, the specimen yields, and finally, rupture occurring, the pencil returns to the base line at a distance from the starting-point which measures the angle through which the test-piece yielded before its fracture became complete.

The curves described vary greatly according to the character of the material. Considerable irregularities in their outline denote a want of homogeneity. They afford means of determining the elastic resistance, the resistance producing a given set, the ultimate resistance, the resiliency, the effect produced by a given weight on a given cross-section, the effect of blows

Fig. 6324.




*Thurston's Testing-Machine.*

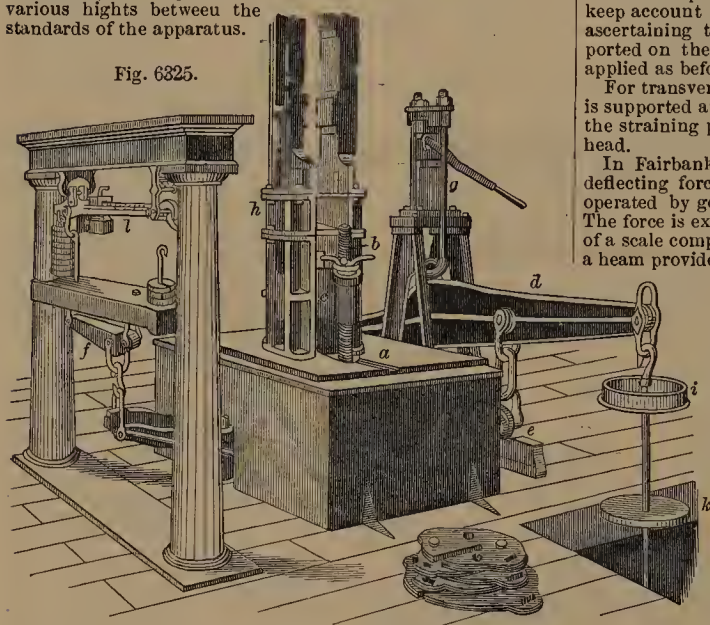
or shocks either originally or when the material has been already subjected to a given tension, and the effect of a series of stresses.

*E* shows the arrangement for investigating transverse strains; the bar to be tested is held in sockets *n n*, one of which is fitted to the recess *l* in one of the axes, and the other in a socket adjustable on the arm *c*.

*F* is employed for directly testing tensile strengths; the wire or rod is fastened at its extremities to the two wheels *w' w'* at-

tached to the ends of the axes $b'$ $c'$ and passes around a wheel $m$, which may be adjusted at various hights betweeu the standards of the apparatus.

Fig. 6325.

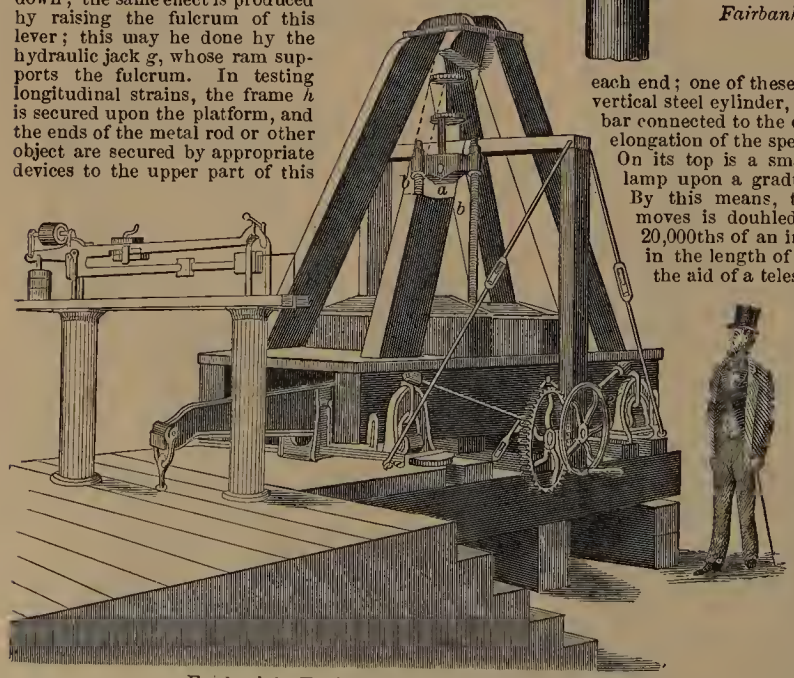



*Colt's Armory Testing-Machine.*

For heavy work a modification $G$ of the machine is employed in which a spring balance or halances, instead of the weight, and a worm-wheel and worm in place of the simple lever $c$, are used; the recording apparatus is somewhat differently arranged, the pencil guide-plate being replaced by a spring, cords, and guide-pulleys.

Fig. 6325 is Richards's machine, used at Colt's Armory, Hartford, Conn. It has a platform $a$ with a central opening, through which pass two screws (one shown at $b$) entering the cross-head $c$, and connected at their lower ends to the two arms of a forked lever below the floor; the long arm of this lever is coupled with the differential levers $d$ $e$ $f$, which act upon the scale-beam in such a manner that hy depressing the free end of the lever $d$, the cross-head is pulled down; the same effect is produced hy raising the fulcrum of this lever; this uay he done hy the hydraulic jack $g$, whose ram supports the fulcrum. In testing longitudinal strains, the frame $h$ is secured upon the platform, and the ends of the metal rod or other object are secured by appropriate devices to the upper part of this

Fig. 6326.




*Fairbanks's Testing-Machine (Perspective View).*

frame and to the cross-head; weights are then applied upon the scale-pans $i$ $k$ until the desired stress is applied, or the tensile limit of the specimen reached The arms of the levers are so proportioned that one pound in either of the pans exerts a force of 120 pounds upon the specimen, and the strain thus applied is measured upon the scale-beam $l$, so that it is not necessary to keep account of the weight actually placed in the pans. For ascertaining the resistance to crushing, the specimen is supported on the platform beneath the cross-head, and pressure applied as before.

For transverse strains, the frame $h$ is removed, the specimen is supported at each end over the opening iu the platform, and the straining pressure exerted hy a knife attached to the cross-head.

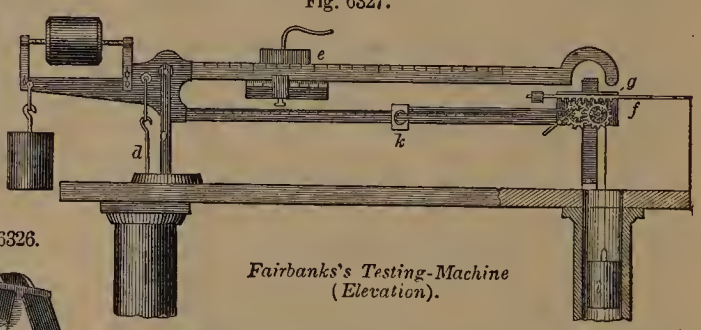
In Fairbanks's testing-machine, thc crushing, breaking, or deflecting force is applied to the speciuen hy a cross-head $a$ operated by gearing and screws $b$ $b$ moved hy a hand-wheel $c$. The force is exerted through the specimen upon the platform of a scale composed of a series of multiplying levers and having a heam provided with peculiar arrangements for automatically indicating the equivalent weight of the force.

In the illustration, $d$ is the rod connecting the heam with the multiplying levers, $e$ a sliding poise which is set at a point rather helow the stress which it is intended to apply. When the force is applied, the beam rises, causing the small lever $f$ pivoted at $g$ to engage a stop $h$; this lifts the teeth of a rack on its under side out of engagement with one of the wheels of a clock-work train, and permits the weight $i$ connected to the poise $k$ on the lower beam to act, drawing out the poise until the equilibrium is restored, when the weighted end of the lever falls, re-engaging the wheel; the poise indicating the exact weight equivalent to the force applied. A fly $l$ retards and equalizes the motion of the clock-work.

If greater force be then applied, the heam again rises, aud the mechanism operates as before, until the crushing or hreaking strain is reached.

In the machine designed by Colonel Flad, used for testing the stone employed in constructing the St. Louis bridge, the specimen is inserted into two collars, one at

Fig. 6327.

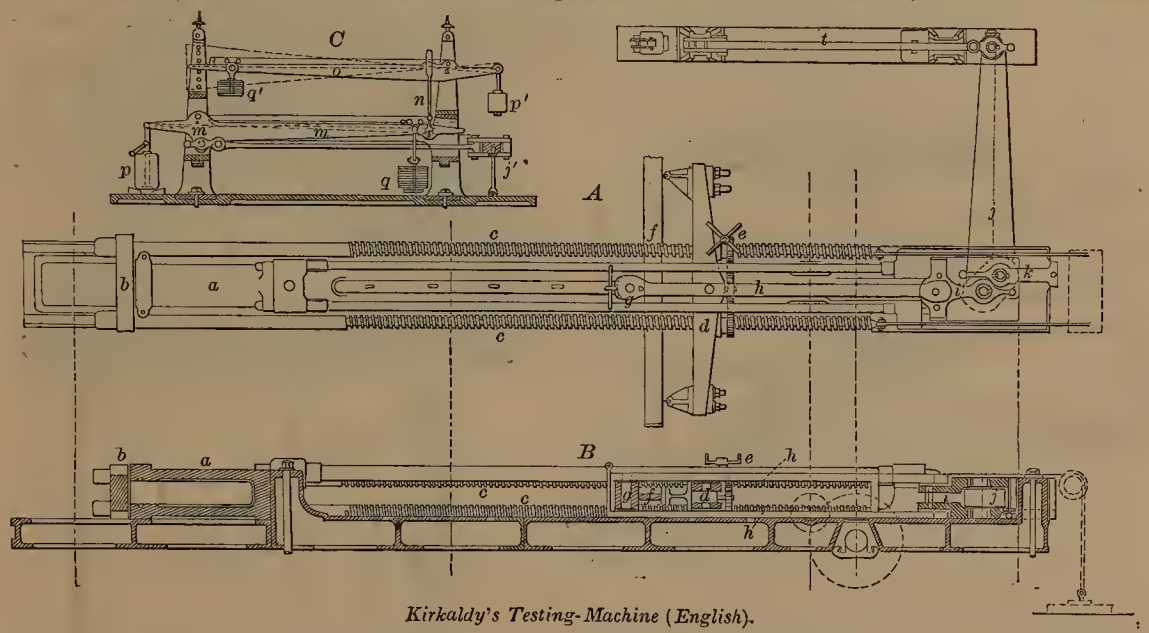



*Fairbanks's Testing-Machine (Elevation).*

each end; one of these has a flat projection supporting a small vertical steel eylinder, which is pressed by a spring against a bar connected to the other collar, so that any compression or elongation of the specimen tends to turn the cylinder around. On its top is a small mirror, which reflects the light of a lamp upon a graduated arc concentric with the cylinder. By this means, the angle through which the cylinder moves is douhled upon the arc, which is graduated to 20,000ths of an inch, so that alterations of that amount in the length of the specimen become visible, and, with the aid of a telescope, 200,000ths of an inch may be estimated.

Fig. 6328 illustrates Kirkaldy's testing-machine (English patent, No. 2970 of 1863). $A$ is a plan, $B$ an elevation of the main frame, and $C$ an elevation of the strain-indicating apparatus. The ram of a hydraulic cylinder $a$ is connected to a cross-head $b$, which slides upon guides on the frame of the machine, and to this cross-head are attached four screw-threaded rods $c$ $c$, passing through a second cross-head $d$, which by means of nuts simultaneously turned hy connected hevel-gears operated by the handle $e$ is caused to have a longitudinal movement along the rods $c$ $c$, for the purpose of adjusting it at the proper position on the frame, according as a bending, crushing, or tearing effect is to be produced. At $A$ the machine is represented in the act of hending a bar of metal $f$, the center of which hears against a knife-edged projection on the hollow hlock $g$, secured in the frame by a strong pintle, and connected by rods $h$ to a T-piece $i$, having a ceutral opening to receive the end of the lever $j$. A pin passes through $i$ and $j$, having a knife-edge rest-

Fig. 6328.




*Kirkaldy's Testing-Machine (English).*

ing against a suitable bearing in the former. A forked piece *k* receives a similar pin passing through it and the lever *j*, and serving as a fulcrum when a strain is brought on the lever through the medium of the rods *h*. The lever is supported at each end upon struts (one seen at *j'*), and its longer end acts upon a link *l* connected with the downwardly projecting branch *m'* of a steel-yard-beam *m*, so as to convert the horizontal movement of the lever into a vertical movement of the beam *m*. This beam is used in testing strains of moderate amount. When powerful strains are to be tested, the pressure is transferred by means of an extensible strut *n* to an upper beam *o*. In each case, as throughout the machine, the levers turn on knife-edge bearings.

The longer arms of each beam are counterpoised by weights *p p'*. The weights *q q'* by which the strain is measured are suspended from carriages running on the upper edges of the beams, and traversed by cords passing over pulleys.

The arrangements for testing, crushing, bending, transverse, compressing, punching, or indenting strains are in general similar; the specimen being placed in the space between the cross-head and cylinder, so as to be subject to a compressive force, while for applying tensile or drawing and similar strains it is placed on the other side of the cross-head, so as to be drawn toward the cylinder *a*. Special appliances for each of these requirements are provided.

See also Greenwood's testing-machine, page 58*, Class VII. Vol. I., "Official Catalogue of English Exhibition of 1862." See also WEIGHING-SCALE.

In the hydraulic tensile testing-machine (Fig. 6329), the ram of the cylinder being pushed back, the specimen is held by the two clips *a b*, and the pump, operated by the lever *c*, causes the ram to exert a pulling strain upon it, which is communicated to a rod connected with the scale-beam, which has a sliding weight and removable weights, indicating the force applied in tons and hundredweights (112 pounds). To remove the iron under test, release the top valve and push back the ram for another test. It is used in testing rods for various purposes, and also for testing links of chain-cables.

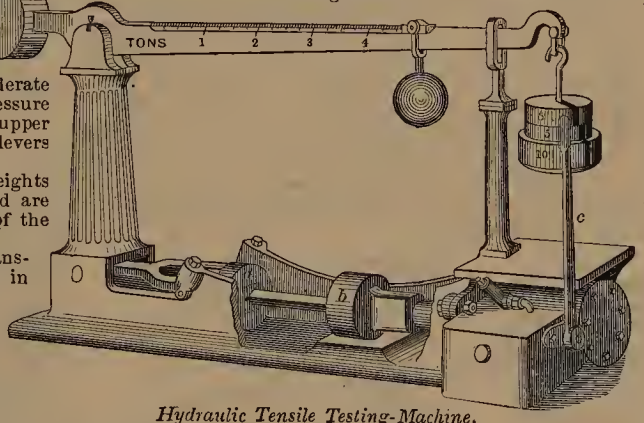
Fig. 6330 is Professor R. H. Thurston's machine for testing the value of lubricants, simultaneous dynamometrical and thermometrical readings being obtained.

In using the machine, a small and determinate quantity of the oil to be tested is placed on the journal *F*, and the pressure being adjusted by the screw *K* to that at which the oil is desired to run under test, the machine is started at a speed which will give the desired relative velocity of rubbing surfaces. Observations are made at short intervals, and recorded, until the test is closed by rapid heating, as shown by the thermometer, and excessive increase of friction, as indicated by the arm *H H* swinging up against its chocks. Competing oils are similarly tried, and the records afford a perfect means of comparison.

Thus sewing-machine builders desire oil of long endurance, and small frictional resistance and viscosity; on locomotives, an oil that will bear high pressure for the greatest length of time without heating is the most desirable, even although not as limpid and of as slight frictional resistance. The relative power of resisting high temperatures without decomposition is another important point which may be tested. See THERMO-ELECTRIC ALARM; TEMPERATURE-ALARM; THERMOSCOPE; etc.

Fig. 6331 is Emerson's apparatus for testing water-wheels. The wheel *b* is secured to the shaft of the water-wheel, and its speed is regulated by the friction-band *a*, which is connected

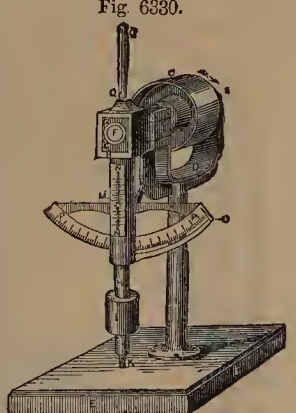
Fig. 6329.




*Hydraulic Tensile Testing-Machine.*

with the scale-beam as shown, the point of connection describing a circumference of 15 feet. The rim of the wheel and the friction-band are hollow, and are kept cool by streams of cold water passing through them. The wheel *b* is made of cast-iron, and the friction-band of gun-metal. The hands of the counter are operated by worm gear, and move like the hands of a clock.

Fig. 6330.



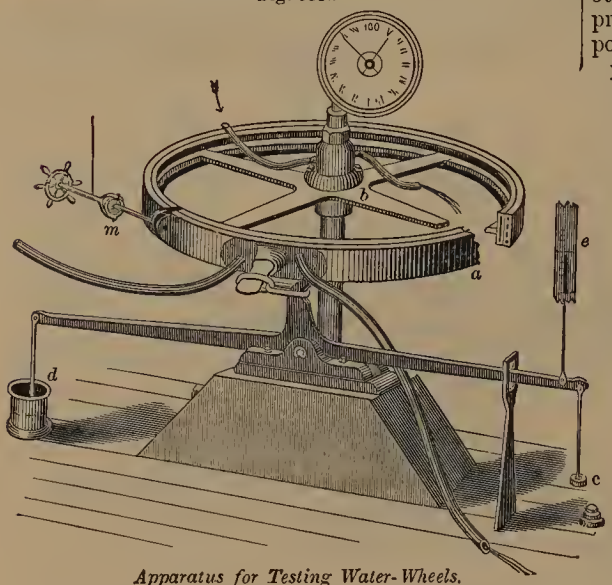
*Testing-Machine.*

The hand-wheel *m* has a universal joint, to prevent fraud. The pivot of the scale-beam and its connections with the friction-band are knife-edged.

The weights are suspended at one end of the beam, as shown at *c*: the other end has attached a plunger working loosely in the cylinder *d*, which is filled with water; this forms the hydraulic regulator for steadying the scale-beam.

The A. H. Emery testing-machine of 400 tons capacity is expected to be completed and at work at the Watertown Arsenal this year. It has an independent straining mechanism, fitted with a strain diagram apparatus, designed by C. E. Emery to produce diagrams somewhat like those of the autographic testing-machine of Professor Thurston. It is expected to cost, including foundations and auxiliary apparatus, about $ 50,000.

Fig. 6331.




*Apparatus for Testing Water-Wheels.*

**Test'ing-slab.** A square plate of white glazed porcelain, having cup-shaped depressions for containing liquids to be examined which give colored precipitates.

**Test-mix'er.** A tall cylindrical bottle having a wide foot and provided with a stopper. It is graduated into 100 or more equal parts, commencing at the bottom, and is used in preparing test-alkalies, test-acids, and similar solutions, by diluting them down to the required strength.

**Test-pa'per.** A paper prepared by dipping into a solution or decoction of a substance and drying; to be used to detect the presence of a substance whose presence causes a reaction and a change in the color of the paper.

| *Paper.* | *Changes to* | *By presence of* |
|---|---|---|
| Brazil-wood paper | Purple | Alkali. |
| Brazil-wood paper | Red | Strong acid. |
| Buckthorn-paper | Red | Acid. |
| Cherry-juice paper | Red | Acid. |
| Dahlia-paper | Green | Alkali. |
| Dahlia-paper | Red | Acid. |
| Dahlia-paper | Yellow | Caustic alkali. |
| Indigo-paper | Decolored | Chlorine. |
| Iodine-paper | Blue | Acid solution of starch. |
| Lead-paper | Black | Sulphuric hydrogen. |
| Litmus-paper (blue) | Red | Acid. |
| Litmus-paper (blue) | Green | Alkali. |
| Rose-paper | Green | Alkali. |
| Starch-paper | Blue | Iodine. |
| Turmeric-paper | Brown | Alkali. |

Fig 6332.

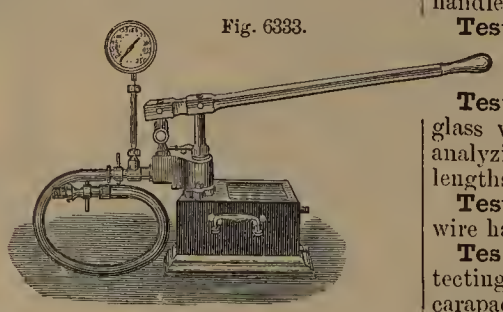
*Test-Mixer.*

**Test-plate.** 1. A finely ruled glass plate used in testing power and defining quality of microscopes. See NOBERT'S TEST-PLATE, pages 1531, 1532.

2. A glass slip used in stirring tests.

**Test-pump.** A force-pump for testing the strength of boilers, tubes, and other hollow articles by hydraulic pressure. It is provided with a gage for showing the pressure in pounds applied to the square inch.

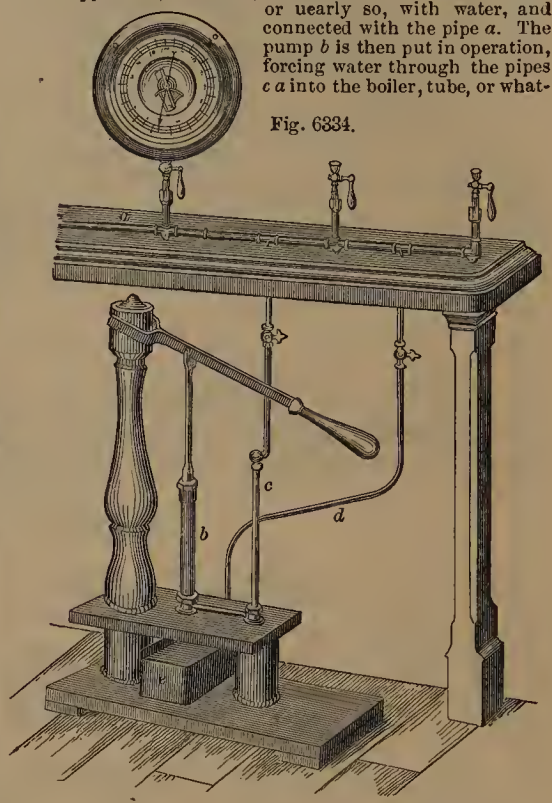
Fig. 6333.



*Test-Pump.*

In the apparatus, Fig. 6334, the article to be tested is filled, or nearly so, with water, and connected with the pipe *a*. The pump *b* is then put in operation, forcing water through the pipes *c a* into the boiler, tube, or whatever the object may be, until it bursts or the maximum proof-pressure is reached; its amount is shown by an index upon a dial. The water in the pipes is, after use, returned to the cistern through the pipe *d*.

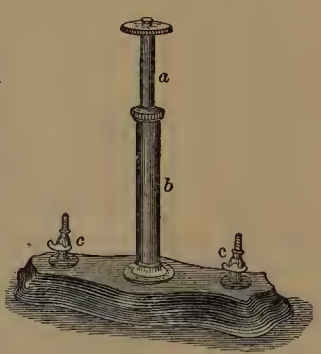
Fig. 6334.




*Test-Pump.*

Shaw's (Fig. 6335) is particularly designed for testing steam and hydraulic gages. The plunger *a* has an interior screw-thread fitting over a screw running the whole length of the cylinder *b*, and is turned by means of a hand-wheel, testing pressures up to 800 lbs. to the square inch; water is introduced into the cylinder through an opening at the top of the plunger, which is closed by a thumb-screw. *c c* are the valves, having screw-threaded nipples, to which gages to be tested are attached.

Fig. 6335.




*Shaw's Test-Pump.*

**Test-spoon.** A small spoon used for taking up small quantities of powders, fluxes, etc.; used in blow-pipe or chemical experiments. The handle may be used as a spatula.

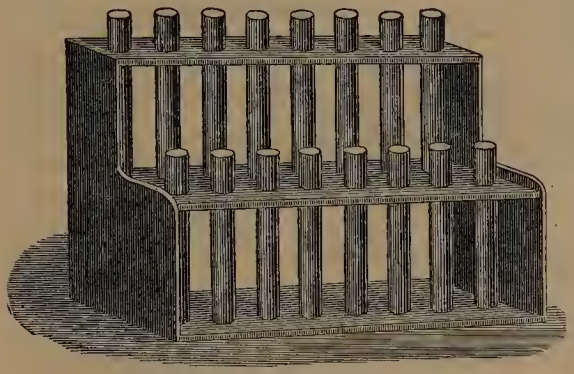
**Test-stir'rer.** A round glass rod, having one end pointed for dropping tests, and the other end rounded.

**Test-tube.** (*Chemical.*) A thin cylinder of glass with a rounded bottom, used in testing and analyzing liquids. They are made of various sizes and lengths. Fig. 6336 shows a stand with test-tubes.

**Test-tube Brush.** A small spiral brush with a wire handle for cleansing test-tubes.

**Tes'tu-do.** 1. (*Military Engineering.*) A protecting device; so called from its resemblance to the carapace of a tortoise. The term was applied by the ancient Romans to a covering formed by joining the

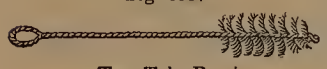
Fig. 6336.



*Test-Tubes and Rack.*

shields of the soldiers over their heads, so as to constitute a species of roof, affording protection from missiles thrown from above; also to a structure movable on rollers or otherwise, for protecting sappers in an attack; and is now applied to objects similar in shape and design employed as defenses for miners, etc., when working in ground or rock which is liable to cave in.

Fig. 6337.



*Test-Tube Brush.*

2. (*Music.*) A species of ancient lyre, the idea of which is said to have been derived from the carapace of a tortoise. See LYRE.

**Tete-a-tete.** Two chairs with seats attached and facing in opposite directions, the arms and backs forming an S-shape.

**Tete-de-pont.** (*Fortification.*) A *redan* or *lunette* resting its flanks on the bank of a river and inclosing the end of a bridge for the purpose of protecting it from an assault.

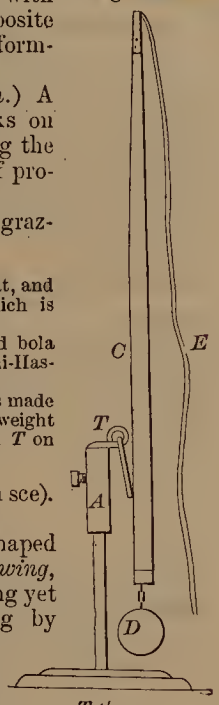
**Teth'er.** A rope by which a grazing animal is tied to a stake.

The rope is frequently termed a lariat, and is secured to an iron picket-pin, which is driven into the ground.

Catching animals with the lasso and bola are both shown on the paiutings of Beni-Hassan in Egypt.

In Fig 6338, the tethering-rope *E* is made fast to a swinging upright *C*, having a weight *D* at bottom and connected to a swivel *T* on the post *A*.

Fig. 6338.




*Tether.*

**Tew'el.** 1. A TUYERE (which see).

2. A pipe or chimney.

**Tew'ing-bee'tle.** A spade-shaped instrument for beating hemp; *tewing*, *touseling*, *tawing*, or *teasing* being yet existing terms for the working by pulling and beating.

**Tex'as.** (*Nautical.*) A structure on the hurricane-deck of a Western steamboat, containing the pilot-house, officers' cabins, etc.

**Tex'tile Fab'ric.**

RAW PRODUCTS USED IN TEXTILE MANUFACTURES.

| Common Name. | Botanical Name of the Genus and Species of the Plant by which the Fiber is produced. | Native Place, or where chiefly grown. | Qualities, Uses, etc. |
|---|---|---|---|
| Agave, or American aloe | Agave americana | Mexico, etc. | Various fabrics and paper are made from this and other species of agave. |
| Amadon | Polyporus formentarius. | Europe | The source of "German tinder." |
| Bamboo | Bambusa arundinaceæ. | Tropics | Paper, cloth, etc., of coarse kinds. |
| Banana | Musa sapientum | Tropics | Various fabrics; the fiber resembles flax. |
| Bast | (See Cuba and Lime.) | | Twine. Tying up cigar-bundles, etc. |
| Bowstring-hemp | Sanseviera zeylanica | India | Strong. Used for cordage, etc. |
| Cactus fiber | Opuntia tuna, etc | Tropics | From layers of the stem. Baskets, ornamental work, etc. |
| China grass, or Rhea | Bœhmeria nivea | China, India, etc. | Fine. Linen, cambrics, nets, etc. |
| Cocoa-nut, or Coir | Cocos nucifera | Tropics | Strong and coarse. Cordage, mats, brushes, bags, ropes, etc. |
| Cotton | Gossypium herbaceum, etc. | Warm countries | Length, strength, etc., of fiber, various East Indian generally coarse and short; American finer and longer. Sea Island and Egyptian have the longest fibers. |
| Cotton (silk) | Bombax ceiba | S. America | A silky substance unfit for spinning. Used for stuffing cushions, etc. |
| Cuba bast | Paritium elatum | Cuba, etc. | A bark. Used to tie up cigars. |
| Daphne | Daphne papyracea<br>Edgeworthia gardneri. | India | Fibrous bark. Used for making paper, etc. |
| Date-palm | Phœnix dactylifera | N. Africa and interior deserts | Plaited work, baskets, from the leaves. |
| Esparto-grass | Lygæum spartum | S. Europe, etc. | Coarse. Matting, cordage, baskets, paper, etc. |
| Fan-palm (dwarf) | Chamærops humilis | Spain, Italy, Tropics | Mats, baskets, caps, etc., from the leaves. |
| Flax | Linum usitatissimum | Temperate climes. | Varieties numerous. Yarn, lineus, cambrics, etc. |
| Flax (New Zealand) | Phormium tenax | New Zealand, etc. | Strong. Cloth, baskets, cordage, etc. |
| Grasses | Very numerous | Generally | Some species, as wheat-straw, used for making paper. All afford fiber variously used; plait for bonnets, brushes, etc. |
| Grass-wrack | Zostera marina | Europ'n sea-coasts | A sea-weed. Used for making mattresses, packing, etc. |
| Gunny, or jute | Corchorus capsularis | India | A coarse kind of jute. Used for making bags, matting, etc. |
| Hair-moss | Polytrichum | England | A moss. Used for stuffing cushions, etc. |
| Hemp | Cannabis sativa | Cool climates and India | In Europe used for cordage, coarse cloth, etc. In India grown for its intoxicating qualities. |
| Ita-palm | Mauritia flexuosa | British Guiana | Affords thread from leaves; of which baskets, fans, mats, etc., are made. |
| Ivy | Hedera helix | Temperate climes. | Coarse. Rope, etc. |
| Jute | Corchorus capsularis | India | In India for "gunny-bags." In England used as an addition or substitute for hemp, flax, and silk. |
| Lace bark | Lagetta lintearia | Jamaica | A bark resembling fine lace; made into collars, sleeves, purses, etc. |
| Lime bast | Tilia europæa | Europe | Affords the material of "Russia matting," etc. |

| Common Name. | Botanical Name of the Genus and Species of the Plant by which the Fiber is produced. | Native Place, or where chiefly grown. | Qualities, Uses, etc. |
|---|---|---|---|
| Mallow | Malva (numerous) | Generally | The tribe comprises cotton, etc., and numerous other fiber-giving species. |
| Manila-hemp | Musa textilis | Philippine Islands. | Various textile fabrics. |
| Maroot-fiber | Sanseviera zeylaniea | Madras, etc. | Resembles and is used as a substitute for flax. |
| Marsh-gladden | Scirpus lacustris | British marshes, etc. | A sedge. Made into baskets, bee-hives, hassoeks, etc. |
| Mulberry | Morus nigra, etc. | China, etc. | The Chinese make coarse eloth out of the bark. |
| Mulberry (paper) | Broussonetia papyrifera. | Polynesia, etc. | The source of "Tapa" eloth, made by beating out the bark by mallets, etc.; resembles both hemp and paper. |
| Namaqua bark | Brosimum namaqua | Grenada, North of S. Amerieа, etc. | Rcsembles hemp. Bark made into sacking, and used for beds, etc. |
| Nettle-fiber | Urtica dioica, etc. | Generally | Irish variety, worked up into collars and other fancy articles. |
| New Zealand flax | Phormium tenax | New Zealand, etc. | (See Flax.) |
| Neyanda-fiber | Sanseviera zeylanica | Ceylon | Resembles and is used as a substitute for flax |
| Palm | Very numerous | Tropies | Speeies very numerous; all afford fiber of some kind. |
| Palmite | Juneus serratus | S. Africa | A rush. Used for plaiting, thatehing, baskets, etc. |
| Palmyra-palm | Borassus flabelliformus | Tropieal Asia | Leaves made into mats, baskets, earpets, hats, umbrellas, etc. |
| Paper mulberry | Broussonetia papyrifera. | Fiji, etc. | (See Mulberry.) |
| Papyrus (paper) | Cyperus | Egypt, etc. | A kind of sedge from whieh ancient Egyptian paper was made. |
| Piassaba | Attalea funifera | Brazil, etc. | Coarse fiber. Made into brooms, ropes, etc. |
| Pine | Pinus (various) | Europe, etc. | Coarse fiber. Fit for ropes, etc. |
| Pine | Thuja gigantea | N. W. America | Bark affords a fiber resembling hemp. Baskets, hats, mats, etc. |
| Pineapple | Bromelia ananas | Tropics | Fiber suitable for fine articles; as muslin, cambrics, etc. |
| Pita-fiber | Bromelia pita, etc. | Tropies | Resembles flax, for which it is an excellent substitute. |
| Plantain | Musa paradisiaca, etc. | Tropies | Various fibers for cordage, etc. |
| Rattan-cane | Calamus rotang | Tropies | When split, used for caning chairs, brooms, etc. |
| Rhea-fiber | Bœhmeria nivea | China, India, etc. | Various textile fabries; the coarse kinds afford cordage, sails, fishing-nets, etc. |
| Riee | Oryza sativa | Europe, India, etc. | Fiber affords a soft porous paper. |
| Riee-paper | Aralia papyrifera | Formosa, China. | The pith of the tree is eut eylindrically, by sharp knives, into thin sheets, affording "Rice paper," used for artificial flowers, painting, etc. |
| Ruffia | Raphia ruffia | Madagascar | Thread is made from the leaves of the palm, and woven into Malagasy eloth, used as garments by the natives. |
| Rushes | Juneus (various) | Generally | Brooms, mats, brushes, baskets, hassoeks, etc. |
| Serew-pine palm | Pandanus spiralis | Tropics | The fiber resembles hemp, and may be similarly used. |
| Sedges | Cyperus (various) | Generally | Brooms, mats, brushes, baskets, etc. |
| Silk-eotton | Bombax ceiba | S. Amerieа | (See Cotton.) |
| Straw | Various, as from wheat, rye, barley, riee, etc. | Generally | Largely used for making paper, bonnet plait, etc. |
| Sugar-cane | Saceharum officinarum, etc. | India, W. Indies, America, etc. | Fiber may be used for making paper, etc. |
| Sunn-hemp | Crotalaria juncea | India | Fiber; an excellent substitute for flax. |
| Talipot-palm | Corypha umbraculifera. | Ceylon | Leaves used as umbrellas, tent-eovers, etc. |
| Teazle | Dipsacus fullonum | England, etc. | The flower of the plant used to raise the nap of woolen eloth. |
| Tueum-palm | Astrocaryum vulgare | Brazil, etc. | Leaves woven to make hammocks, etc. They also afford thread. |
| Willow | Salix (various) | Temperate climes. | Baskets, bonnets, plait, etc. |
| Yereum-fiber | Calotropis gigantea | India | Resembles flax; the seeds are inclosed in a silky fiber, like thistle-down. |

**Text-pen.** An engrossing pen.

**Thal-las-som'e-ter.** A TIDE-GAGE (which see).

**Thal'li-um.** A metal discovered by means of the spectroscope by W. Crookes, in 1861. A rare metal resembling lead in appearance, allied by action with the alkaline metals.

**Tharm.** Twisted gut.

**Thatch.** Roof covering of straw, reeds, or rushes; of dried grass or palm-leaves in the tropics.

Thatching is performed with reeds, straw, or fern. It is very unusual in the United States, but is a common and excellent roof in many countries of Europe. The best material is the marsh reeds of Eastern England and of Holland. The reeds are cut in the winter, made into sheaves, dried and stacked. With eare, a roof of thateh will last over 100 years. Reed-thatched roofs in Holland are shown which are 200 years old, and in good preservation.

The reeds are laid in successive courses 8 or 9 inches in thickness, the buts toward the eaves, and are held down to the roof spars by *sways* or rods, whieh are tied to the roof-spars by rope-yarns passed through the reeds by a needle. The total thickness given at the eaves is 18 or 20 inches, and the buts of each suceeeding course overlap on the eourse below. The *legget*, a square pieee of board with au oblique handle, is used for driving up the buts of the reeds and making them lie eompactly. The ridge of the roof, where the small ends of the reeds meet, is capped with straw.

The most aneient mode of roofing was of boughs, or, in Oriental countries, of leaves. Thatch of reeds or straw is also very ancient. Servius and Plautus mention thatch, and Herodotus mentions a thatch of reeds as the usual covering of the houses in Sardis. The northern nations of Europe are noticed as using thatch, as did also the Helvetii and Anglo-Saxons.

Shingles were used in Rome till A. U. C 470. Slates, with iron pins, have been found in Romau remains, and iu England of the date 1322.

Tiles of clay are deelared by Pliny to have been invented by Cinyra, son of Agriopè. Byzes used stone slabs; others marble, even gold, but more usually bronze gilt. Hollow tiles were used in the construction of tombs. Anglo-Saxon and Norman tiles were taken from the Roman. Pantiles were used in the Middle Ages, and very generally in the fifteenth century.

The most ancient existing roofs in England are of wooden boards covered with lead.

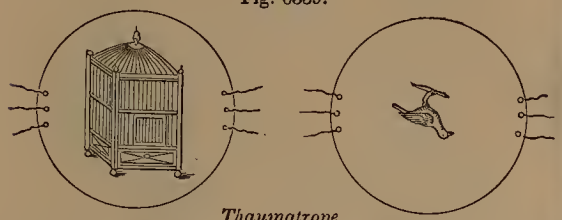
**Thatch-wood Work.** (*Hydraulic Engineering.*) A mode of facing sea-walls with brushwood. Underbrush of say twelve or fourteen years' growth is cut down, fagoted at its full length, and spread over the face of the banks. It is kept down by strong stakes, whieh have cross pins at their upper ends to rest upon the brush, which breaks and disperses the waves and protects the earth beneath.

**Thau'ma-trope.** The theory of the duration of visible impressions was taught by Leonardo da Vinci, who was born in 1452. Many curious toys and scientific devices have been made, founded upon this

principle. The THAUMATROPE, and, more lately, the PHENAKISTOSCOPE, ZEOTROPE, STROBOSCOPE, and ANORTHOSCOPE, are examples. See under these heads.

The idea of this contrivance originated with Sir John Herschel, and depends upon the limit to the rapidity with which visual images may be substituted and separately distinguished. Mr. Babbage mentions the circumstances under which the idea was

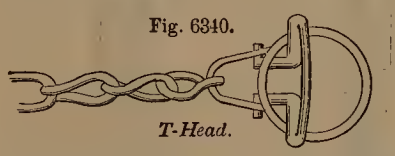
Fig. 6339.



*Thaumatrope.*

brought into practice, which was effected by spinning a shilling with such rapidity that the visual image combined the figures on each side of the coin. It was subsequently made in the form of a toy, in which the respective sides showed a horse and his rider, a bird and his cage, a rat and a trap, etc., according to the taste or ingenuity of the contriver.

Fig. 6340.



*T-Head.*

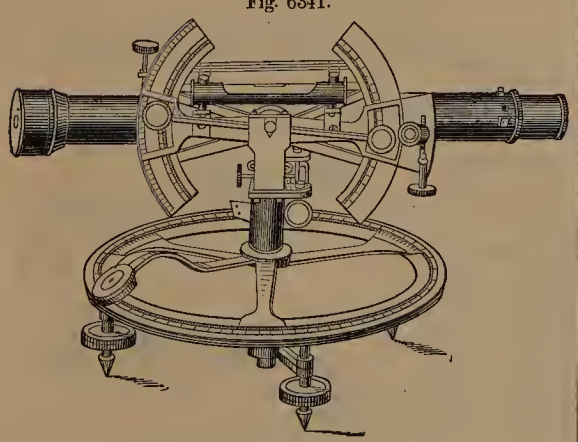
**T-head.** A cross-bar with two prongs on the end of a dog-chain, watch-chain, or elsewhere, to engage in a ring.

**The-at'ri-cal Ma-chine'.** Made of wire cloth running on rollers, and wound up and unwound by power. Parsons' patent, June 2, 1874.

**The-od'o-lite.** An instrument for measuring horizontal and vertical angles, but particularly adapted for accurately measuring the former. Its principle is identical with that of the altitude and azimuth instrument; the construction and purpose of the two, however, differ, the latter being employed for astronomical purposes, while the theodolite is used for land surveying; but the better instruments of this class may be employed for observing the altitudes of celestial bodies. The vertical circle is not generally, however, of sufficient size, nor so graduated as to be available for very accurate astronomical observations.

This iustrument has beeu used in extensive geodetical operations iu England and in this country, such as the British Ordnance Survey and the Uuited States Coast Survey, while in Fraunce the repeating circle of Borda has been preferred. The telescope has a motion on a horizontal axis, and has a vertical graduated circle, which has also a horizontal.

Fig. 6341.



*Everest's Theodolite.*

See under TELESCOPE for notice of the first use of telescopes in triangulation or measuring angles.

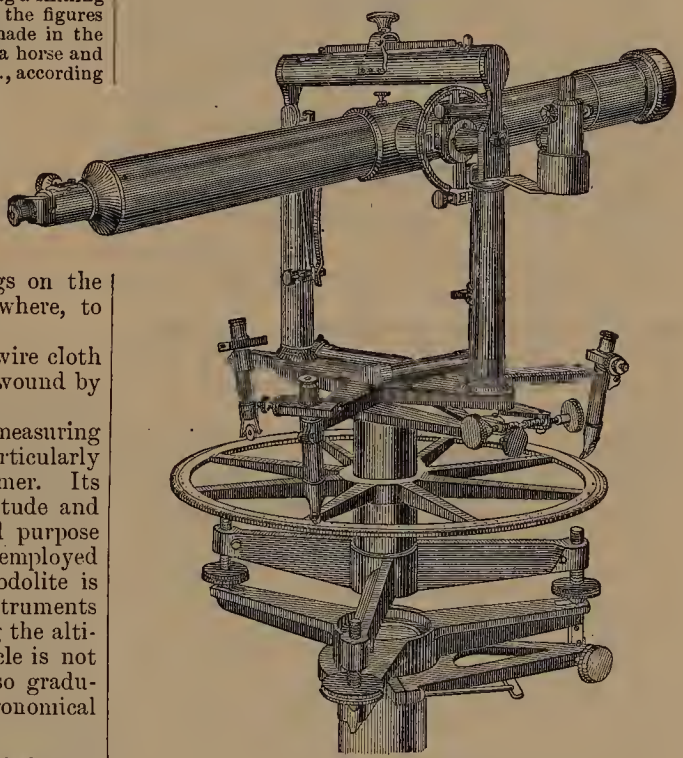
The first survey made by an instrument with a perfect circle is said to be that of Zealand, by Bugge, in 1762–68.

Ramsden's theodolite had a circle 3 feet iu diameter, and was completed in 1787. It had two telescopes of 36 inches focal length. It was used for a triangulation to connect the observatories of Greenwich and Paris, and also in the Euglish, Irish, and Indian trigonometric surveys.

The telescope circle and stand are capable of motion round a vertical axis. The altazimuth may be considered a modification of the transit instrument, and has beeu called a transit theodolite, being adapted for meridional or extra-meridional observations indifferently. Everest's theodolite is so called from its designer, Sir G. Everest, late of the East Indian Survey, and is among the best of its class.

The Wurdemann's theodolite, used by the Coast Survey, is mounted upon a repeating stand, that is, one which has an axis of its own, having a clamp and tangent so as to read any angle on any part of the limb. This stand has adjusting feet for leveling, so as to bring the axis vertical on uneven ground. The base of the instrument proper consists of a leveling tripod, from which rises a central column formiug the barrel of the

Fig. 6342.



*Würdemann's Theodolite.*

axis; on the outside of the column the main *limb* of the instrument is fastened. The central column is of cast-iron, and the principal vertical axis of steel plays within the coluun. The upper or large end of the axis has attached to it a plate carrying, firstly, three reading micrometer microscopes, 120° apart; secondly, two columns with Y's for receiving the pivots of the telescope axis. The pivots rest with one half of the diameter in the Y's, the other half projecting for the legs of the striding level to rest upon.

The telescope is 38 iuches focal length, the object-glass 2 $^{9}/_{10}$ inches aperture, provided with a 4-inch vertical finder-circle for use in taking solar or star azimuths, and ou the right-hand side of the telescope is the usual clamp and tangeut for vertical fixture and movement. A small central reflector of $^{1}/_{10}$ inch diameter throws the light from a lamp attached outside to the cross lines of the eye-piece. The light from the lamp, passing through the telescope axis to the ceuter of the tube, is reflected upon the wires by the reflector. The wires are contained in a micrometer eye-piece.

The clamp and tangent for the horizontal movement of the alidade is not, as usual, attached to the horizoutal circle, but on a collar immediately underneath the alidade on a separate disk. The clamp arm fitting on this disk contains a piece of steel which is pressed against the disk by means of the clamp-screw, which fixes the arm, a small portion of the clamp-ring being cut out opposite to the screw, so that there are but three points of contact in clamping. To the outer end of this clamp-arm is attached one portion of the tangent screw, whilst the other holds to a projecting part of the alidade plate.

Two cross levels on the alidade plate afford means for perfectly leveling the instrument. The micrometer microscopes read to one minute of arc to one revolution of the screw. The drum of the screw is divided into 60 divisions, each having the value of 1″, of which tenths are generally estimated, and are quite perceptible.

The peculiar features of the instrument are, —

1. The circle is freed from the clamp and tangent, being independent.

2. The optical power is high. Without this, mere size of the instrument is of little advantage. For instance, the microscopic readings on the limits may be read to as great accuracy, 10″, as the five-foot mural circle of the Naval Observatory, Washington.

*Lengths of a Degree of Longitude on the Parallels of Latitude, for each Degree of Latitude from the Equator to the Pole.*

| Lat. | Miles. | Lat. | Miles | Lat. | Miles. | Lat. | Miles | Lat | Miles. |
|---|---|---|---|---|---|---|---|---|---|
| 1° | 59.99 | 19° | 56.73 | 37° | 47.92 | 55° | 34.41 | 73° | 17.54 |
| 2 | 59.96 | 20 | 56.38 | 38 | 47.28 | 56 | 33.45 | 74 | 16.54 |
| 3 | 59.92 | 21 | 56.01 | 39 | 46.63 | 57 | 32.68 | 75 | 15.53 |
| 4 | 59.85 | 22 | 55.63 | 40 | 45.93 | 58 | 31.79 | 76 | 14.52 |
| 5 | 59.77 | 23 | 55.23 | 41 | 45.28 | 59 | 30.9 | 77 | 13.5 |
| 6 | 59.67 | 24 | 54.81 | 42 | 44.59 | 60 | 30. | 78 | 12.48 |
| 7 | 59.55 | 25 | 54.38 | 43 | 43.88 | 61 | 29.09 | 79 | 11.45 |
| 8 | 59.42 | 26 | 53.93 | 44 | 43.16 | 62 | 28.17 | 80 | 10.42 |
| 9 | 59.26 | 27 | 53.46 | 45 | 42.43 | 63 | 27.74 | 81 | 9.38 |
| 10 | 59.09 | 28 | 52.97 | 46 | 41.68 | 64 | 26.3 | 82 | 8.35 |
| 11 | 58.89 | 29 | 52.48 | 47 | 40.92 | 65 | 25.36 | 83 | 7.31 |
| 12 | 58.69 | 30 | 51.96 | 48 | 40.15 | 66 | 24.4 | 84 | 6.27 |
| 13 | 58.46 | 31 | 51.43 | 49 | 39.36 | 67 | 23.44 | 85 | 5.23 |
| 14 | 58.22 | 32 | 50.88 | 50 | 38.57 | 68 | 22.48 | 86 | 4.18 |
| 15 | 57.95 | 33 | 50.32 | 51 | 37.76 | 69 | 21.5 | 87 | 3.14 |
| 16 | 57.67 | 34 | 49.74 | 52 | 36.94 | 70 | 20.52 | 88 | 2. |
| 17 | 57.38 | 35 | 49.15 | 53 | 36.11 | 71 | 19.53 | 89 | 1.05 |
| 18 | 57.06 | 36 | 48.54 | 54 | 35.27 | 72 | 18.54 | 90 | .00 |

NOTE. — Degrees of longitude are to each other in length as the cosines of their latitudes.

**The-od'o-lite-mag'net-om'e-ter.** An instrument employed as a declinometer to measure variations in declination, and as a magnetometer in determinations of force.

It consists of a graduated horizontal circle, mounted as in the ordinary surveyor's theodolite, upon which is fixed a small wooden box In the top of this box a vertical glass tube is fastened. The magnet is suspended in the box by means of one or two filaments of unspun silk, which pass up through the tube and are fastened at its top. The magnet consists of a perfectly turned steel tube, in one end of which there is a glass head. On this head a scale is engraved, which is so delicate that it is scarcely visible to the naked eye. The other end is closed with a lens which brings the rays of light in parallel directions to the scale. Connected with the horizontal circle of the instrument is a small telescope, mounted so that its axis shall lie in the produced axis of the box. In each end of the box is a small glass window, so that when the apparatus is properly adjusted, the light will come through the magnet to the eye of an observer, and the scale on the magnet-head will be visible.

To determine the magnet declination we have only to make the vertical wire of the telescope coincide with the axis of the magnet, and note on the horizontal circle the angle which this line makes with the direction of the true meridian, which is before determined. The variations in declination may then be determined from time to time by noting the reading of the magnet-scale.

In observations for magnetic force, Gauss's method is generally employed. The suspended magnet is made to swing horizontally in the box through a very small arc, and the time of a single oscillation is noted. The same magnet is then made to deflect another suspended magnet, from a certain fixed position and at a known distance, and the angle through which the second magnet is deflected is observed. Each of these experiments determines a value which is due to the combined effects of the magnetism of the earth and of the magnet. But these effects are, in the two cases, combined in different ways, so that, by a proper combination of the two values, we may eliminate the effect due to the magnetism of the magnet, and obtain that due to the horizontal magnetic intensity of the earth alone.

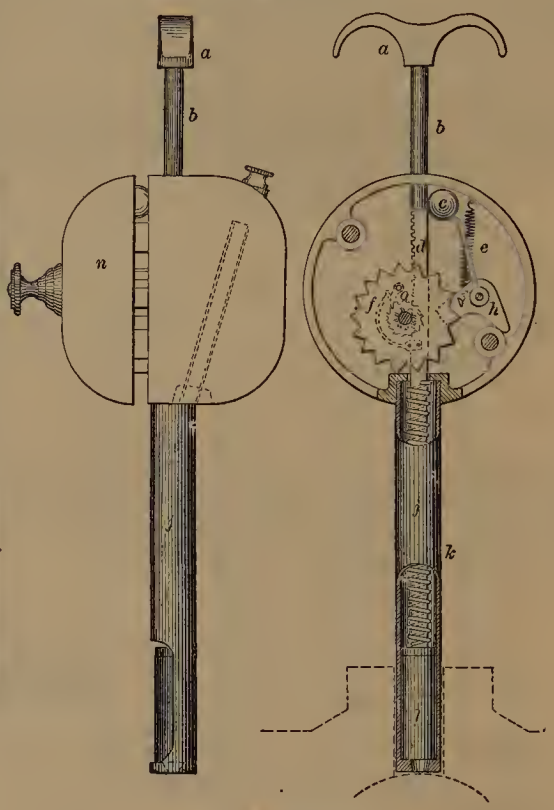
**The-or'bo.** (*Music.*) A large lute, having two heads, to each of which strings are attached.

"One slovenly and ugly fellow, Signor Pedro, who sings Italian songs to the theorbo most neatly." — PEPYS'S *Diary*, 1664.

**Ther'mal A-larm'.** An attachment for giving indication of a hot-bearing.

A tube *j* has a plug *l* of such material or alloy as will melt at the degree at which it is desired the alarm should be given.

Fig. 6343.




*Hot-Bearing Alarm.*

See table of fusible alloys, page 62. As the plug melts on the hot-bearing and escapes at the hole beneath, the spring *k* forces down the spindle *b*, giving motion to the rack *d*, pinion *o*, and striking-wheel *f*. The wheel *f* operates the pallet *h* and hammer *c*, causing the latter to strike the gong *n*. *a* is the handle for withdrawing the spring in inserting a plug. See Fig. 6346.

**Ther'mal Mo'tor.** A machine in which the expansion and contraction of an object or material, by changes in the temperature, is made a means of motion. The term is usually applied to machines operated by natural thermometric changes.

Coxe, 1827, in London exhibited a timepiece which was kept in continual action by the rise and fall of a column of mercury in a barometric tube attached thereto.

The plan has been frequently tried elsewhere.

In Washburn's thermal motor, July 4, 1865, the expansion and contraction of a bar of metal, under the influence of natural heat, are gathered up by means of springs and levers, so that the power can be used for propelling machinery, clock-work, and similar purposes.

**Ther'mal U'nit.** In British parlance, that quantity of heat which corresponds to an interval of 1° Fah. in the temperature of 1 pound avoirdupois of water at 39.10° Fah.

It is to the French thermal unit as 1 : 3.96832.

The French unit is 1° Centigrade in 1 kilogramme of water.

**Ther-met'o-graph.** A self-registering thermometer, recording the maximum and minimum of temperature in a given time.

Fig. 6344.

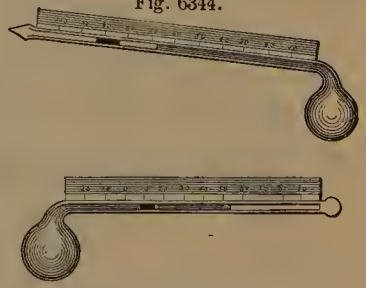


Fig. 6344, Rutherford's thermetograph, consists of two thermometers, one containing mercury and the other alcohol. A steel wire is pushed before the column of mercury and left at the maximum point reached. An enamel slide in the

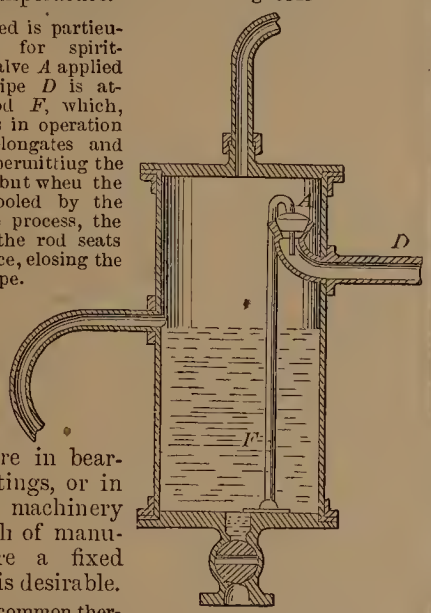
*Rutherford's Thermetograph.*

alcohol thermometer is drawn back by the liquid and left at the minimum point.

**Ther'mo-ba-rom'e-ter.** An instrument for measuring altitudes by means of determining the boiling-point of water. See HYPSOMETER; EBULLIOSCOPE; BAROMETER.

**Ther'mo-dy-nam'ic Valve.** A valve depending for its operation upon the expansion and contraction occasioned by changes of temperature.

Fig. 6345.



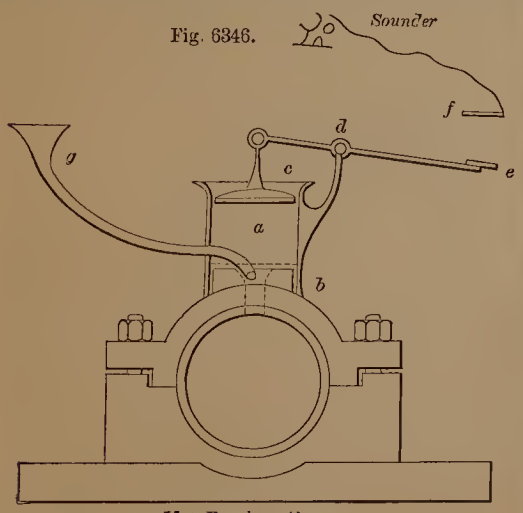

*Check-Valve for Liquid-Meters.*

That illustrated is particularly designed for spirit-meters. The valve *A* applied to the pump-pipe *D* is attached to a rod *F*, which, when the still is in operation and heated, elongates and lifts the valve, permitting the liquor to flow; but when the apparatus is cooled by the stoppage of the process, the contraction of the rod seats the valve in place, closing the mouth of the pipe.

**Ther'mo-e-lec'tric A-larm'.** An apparatus designed to indicate the rise of temperature in bearings for shaftings, or in any kind of machinery or any branch of manufacture where a fixed temperature is desirable.

It resembles a common thermometer, except that it has a wire secured at top and bottom. The wire at the bottom passes through the bulb and touches the mercury. The other wire enters the glass at the top and extends part way down the inside. Each of these wires is connected with a small open circuit having a battery and an electric bell. When this connection is made and the battery in order, the glass may register (say) 40°. The upper wire hangs down in the glass (say) to 85°, the circuit being open by the space between the top of the column of mercury and the bottom of the wire. When the mercury rises and touches 85°, the circuit is closed and the bell sounded. When the column of mercury sinks, the circuit is broken and the bell stops. The upper wire may be adjusted to any figure on the scale. For refrigerators, the end of the wire may touch the freezing-point; for chambers or school-rooms, it can be set at 70°; to indicate the presence of fire, it may be set at 100° or upward. In the case of hotels, a glass in every room, each with its wire circuit, may ring an alarm-bell in the office the instant the temperature rises above a fixed hight. To indicate the particular room, a common electric annunciator is attached to the system of circuits, and the clerk or watchman informed of the exact position of the danger. By fixing the glasses at a comparatively low figure (say 90°), they serve a double purpose,—show if the room is too warm from overheating or in danger from fire. When used as an indicator of the want of oil or other lubricant on bearings for car-wheels, shafts, and the like, the hot journal quickly raises the mercury, and, by closing the circuit, starts the alarm-bell, which continues to ring till the shaft is stopped or cooled. For this purpose a hole is drilled in the bearings, and the thermometer sunk in it till the bulb rests on the shaft. This device is also used to indicate any required temperature in boiling drugs, dye-stuffs, or other liquids.

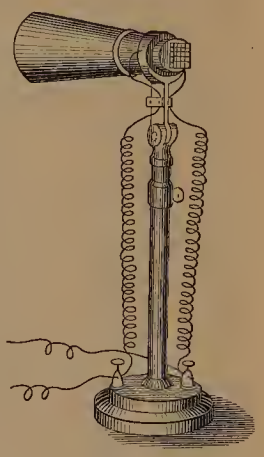
Fig. 6346.




*Hot-Bearing Alarm.*

Fig. 6346 consists of a cylindrical box *a* provided with a perforated bottom *b*, and placed directly over the journal. The box is filled with a prepared grease which melts at a certain temperature, to which it must be raised by the shaft becoming hot. As the compound liquefies and escapes through the perforations, a disk *c*, which rests thereon, descends, thereby tilting the lever *d*, and so making contact between the plates *e* and *f*. The latter are connected by an electric circuit with a bell which sounds when the current is established. The pipe *g* serves for the ordinary lubrication of the journal.

Fig. 6347.



*Thermo-Electric Pile.*

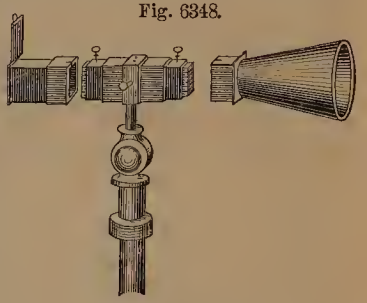
See also TEMPERATURE-ALARM; THERMOSCOPE; THERMOMETRIC ALARM; etc. See also TESTING-MACHINE, Fig. 6330.

**Ther'mo-e-lec'tric Bat'tery.** (*Electricity.*) One in which an electric current is established by applying heat or cold to one of the junctions in a circuit composed of two different metals. It was first shown by Seebeck of Berlin in 1821. See Deschanel's "Natural Philosophy," Part III. pages 652, 653.

Figs. 6347, 6348, illustrate ordinary forms of the apparatus.

Fig. 6349 shows the battery or pile of Melloni. *b c* are an enlarged view and a section of the elements.

Fig. 6348.

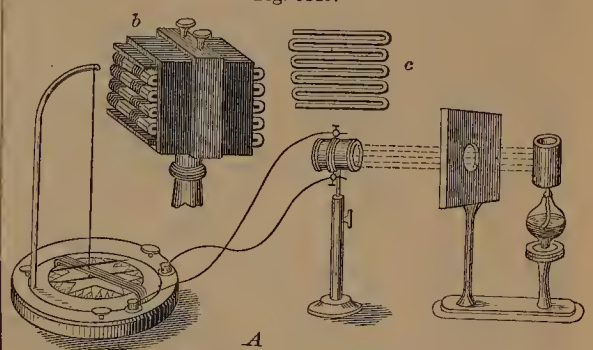


*Thermo-Electric Pile.*

At the Exposition of 1867 were exhibited three batteries of this class: those of Farmer, American; Marcus, Austrian; and Ruhmkorff, French.

The former consists of strips of copper and wedge-shaped blocks of an alloy arranged alternately in the form of a ring. The strips of copper are soldered at each end alternately, and insulation between the metals is effected by interposed plates of mica. Heat is applied to the inner edge of the ring by means of a circular gas-burner. It was stated that thirty-six elements of this battery were equal to one of Grove's.

Fig. 6349.




*Melloni's Thermo-Electric Battery.*

In the battery of Professor Marcus, the positive and negative elements are both alloys: the former consisting of 10 copper, 6 zinc, and 6 nickel; and the latter of 12 antimony, 5 zinc, and 1 bismuth. The bars are arranged after the manner of the rafters of a house, and soldered together at their alternate extremities, separated by a slight interval, no insulating material being

employed. Their lower ends are immersed in water heated by a spirit-lamp. 65 pairs of this battery were capable of developing a lifting force of from 25 to 50 kilogrammes in an electro-magnet.

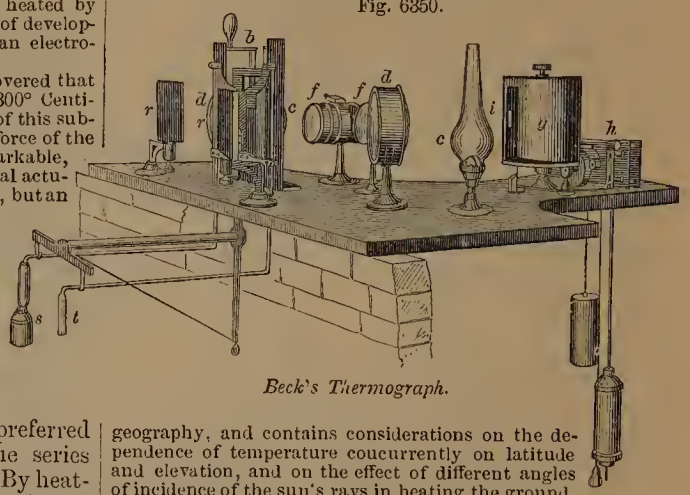
Becquerel's battery was invented in 1835. He discovered that artificial sulphide of copper when heated to 200° or 300° Centigrade is strongly positive, and that a couple formed of this substance and metallic copper has nearly ten times the force of the ordinary antimony and bismuth couple. This is remarkable, as the native sulphide is strongly negative. The metal actually used for the negative element is not pure copper, but an alloy of 90 copper and 10 nickel (German silver). The elements are arranged in a manner resembling that of Marcus, their ends being immersed in water heated by means of a gas-burner. Eight or nine of these elements are considered by M. Becquerel to be equal to one of Daniell's. With fifty couples an electro-magnet has been made to sustain a weight of 100 kilogrammes (220 lbs.).

**Ther'mo-e-lec'tric Pile.** A series of metallic plates, or a chain of links of alternate metals, — antimony and bismuth are preferred as being farthest apart of the metals in the series Bi., Pt., Pb., Sn., Cu., Ag., Zn., Fe., Sb. By heating one or more of the junctions, electricity is developed. See THERMO-ELECTRIC BATTERY.

**Ther'mo-graph.** An instrument for automatically recording variations of temperature.

In the apparatus, Fig. 6350, this is effected by means of photography. The instrument when in use is inclosed in a box, and all light is excluded except that which is admitted through an air-speck in each thermometer. *g* is a cylinder on which the photographic paper is wound, and is rotated by clock-work *h* once in forty-eight hours; *i*, shutter cutting off the light for four minutes every two hours, and leaving a white line when the paper is developed; *s*, wet-bulb thermometer; *t*, atmospheric thermometer; *b*, screw for adjusting thermometers to the required hight; *c c*, gas-lights; *d d*, condensers throwing the light on to the mirrors *r r* through air-specks in the thermometers, the light passing through slits *e e*; *f f*, photographic lenses throwing an image of the air-speck in each thermometer upon the paper on the cylinder *g*, and leaving two irregular dark lines corresponding to the varying hights of the wet-bulb and atmospheric thermometers.

Fig. 6350.




*Beck's Thermograph.*

**Ther-mom'e-ter.** A heat-measurer. The term is generally applied to a glass tube, terminating in a bulb, which is charged with a liquid, usually mercury or colored alcohol. The liquid contracts or expands with changes of temperature, falling or rising in the tube against which is placed a graduated scale.

Perhaps the earliest account we have of an instrument for measuring the heat of the atmosphere is that noticed in the "Spiritalia" of Hero of Alexandria, about 150 B. C., which is described as a tube or vessel wherein the water is made to rise or fall by the changes of heat and cold.

The Spanish Saracens had detected the variation in the density of liquids by changes in temperature, but appear not to have noticed the variation in volume. They therefore used a *hydrometer* as a measurer of temperature See AREOMETER.

The air-thermometer of Santorio, of Padua, constructed about the beginning of the seventeenth century, consisted of a glass tube *a* having at one end a glass ball and open at the other; this tube, having been heated to rarefy the internal air, had its open end placed in a cup of colored liquid, which, by the pressure of the atmosphere, was forced up into the tube.

The expansion by heat of the air in the bulb depressed, and its contraction at a lower temperature elevated, the liquid in the tube. This instrument still lives in a modified form in the SYMPIESOMETER (which see), and was in fact a better barometer than thermometer, though in fact all barometric readings need thermometric corrections. See also AIR-THERMOMETER, Fig. 116.

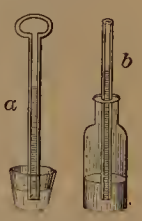
Santorio employed the instrument as a clinical thermometer to measure the heat of the skin in diseases, and at different periods in the same disease. See also SPHYGMOMETER.

The instrument of Santorio was improved by Boyle, who inserted a tube *b*, open at both ends, through the neck of a bottle containing some colored liquid. A portion of the liquid was then drawn up into the tube The mouth of the bottle being hermetically sealed, the expansion of the contained air caused the column of liquid to rise, and its contraction caused it to fall The bottle could be dipped in hot or cold liquids. The instrument was faulty, as the liquid was subject to contamination and evaporation. This was before the time of mercury as a charging liquid.

The Florentine Academicians introduced the present mode of construction, — a tube with a bulb on its lower end to contain the liquid, and an exhausted stem hermetically sealed

A work of Albertus Magnus, bearing the title of "Liber Cosmographuris de Natura Locorum," is a species of physical geography, and contains considerations on the dependence of temperature concurrently on latitude and elevation, and on the effect of different angles of incidence of the sun's rays in heating the ground.

Fig. 6351.




*Thermometers.*
*a. Santorio.*
*b. Boyle.*

"In the department of the distribution of temperature and meteorology, attention was already directed, at the end of the fifteenth and beginning of the sixteenth centuries, to the decrease of temperature with increasing western longitude (the inflection of the isothermal lines); to the law of rotation of the winds, generalized by Francis Bacon; to the diminution of atmospheric moisture and of the quantity of rain, caused by the destruction of forests; and to the decrease of temperature with increasing elevation above the level of the sea and the lower limit of perpetual snow. That this limit is 'a function of the geographical latitude' was first recognized by Petrus Martyr Anghiera in 1510."— HUMBOLDT.

Previous to the introduction of the plan of completely inclosing the temperature-measuring fluid in an air-exhausted tube, — the work of the Florentine Academicians, it was impossible to obtain reliable data as to the relative distribution of heat and the winter and summer variations of temperature upon different parts of the earth's surface. At present, thanks to the numerous and systematic observations which have been made at all points generally accessible to civilized observers, the laws by which this distribution is governed have been in a great degree ascertained. Nor does this apply to air-currents alone. By the aid of the thermometer the Gulf Stream and the other great oceanic currents have been discovered and mapped out, and light has been thrown upon their origin, and the effects which they produce in modifying the climate of extensive regions of the globe, and influencing the characters of their flora and fauna.

Since the days of Dr. Franklin, who by its aid first positively determined the existence of the Gulf Stream, this little instrument has become of great importance to the mariner, who may frequently, by the decreased temperature of the water, ascertain his proximity to land and to icebergs or other dangers, when it cannot be detected readily by other means.

On an average, the thermometer falls about 1° for each 300 feet of elevation above the surface of the sea. Were it not for the great fluctuations in its indications, due to various causes, this might be availed of as a rough method of determining vertical hights. The determination of the boiling-point of water, which depends upon the absolute density of the atmosphere and not upon the temperature, falling 1° for each 450 feet of elevation, affords a much more accurate means of approximately determining hights above the sea-level. With a simple apparatus specially contrived for this purpose and a good thermometer, a degree of accuracy approaching that of the barometer may be attained. See HYPSOMETER.

In making thermometers, tubes are selected having as nearly as possible a uniform bore throughout. A column of mercury an inch or less in length is then introduced, and the tube connected to a flexible india-rubber bag at each end.

By means of screws, one bag is compressed while the other is expanded, and the mercury is thus gradually forced from one end of the tube to the other, the space which it occupies at each part of the tube is noted, and, in graduating, the degrees at each portion of its length are made longer or shorter in proportion to the length occupied at that part by this short column of mercury; this preliminary process is called *calibration*.

The required dimensions of the bulb are found approximately by weighing a measured length of the mercurial column, and computing the capacity of the bulb from the known expansion of mercury and its specific gravity.

The bulb may be formed upon the tube previous to calibration, or attached afterward. This is done by heating one end of the tube in the blow-pipe and forcing in dry air from an india-rubber bag.

For putting in the mercury, a small reservoir of paper or glass

containing mercury is fixed upon the upper end of the tube. Heat is then applied to the bulb, which, driving out the air, forces the mercury to descend by atmospheric pressure. The upper end of the tube is next heated and drawn out, ready to be hermetically sealed. The mercury is then boiled in the tube, its vapor driving out all traces of air, and, while in a state of ebullition, the tube is sealed by directing the flame of a blow-pipe against its upper end, which fuses the glass and closes the aperture.

Another mode of filling is to heat the bulb and immerse the open end of the tube in a reservoir containing mercury.

The freezing-point is determined by placing the bulb in finely pounded ice, from which the water drains away as it melts This temperature is fixed and invariable under all circumstances.

The boiling-point is obtained by placing the bulb in steam having the same elasticity as that of the atmosphere; a peculiar apparatus, devised by Regnault, being generally employed for the purpose. As the temperature of boiling water varies with different barometric pressures, it is necessary that a uniform standard should be assumed; this is taken at 30 inches in this country and England, or 760 millimetres in France; and should the hight of the barometer vary from this at the time, a correction of the apparent boiling-point on the tube is necessary to give the true hight of that point.

At the Tower Manufacturing Company's establishment, Chester, Pa., the tubes, which are received in lengths of about one yard, are nicked and broken off to the proper length. The bores are then examined with a lens, and the tubes assorted into ten sizes, and then passed to the glass-blowers. Each of these is provided with an oil lamp and a pair of foot-bellows. Melting the glass at one end, he blows it into a bulb proportionate in size to the bore of the tube by forcing in air from an india-rubber ball applied to the other extremity, and while yet hot he immerses this end in mercury, which, as the bulb cools, rises and partially fills it. The tube is then withdrawn, and a short india-rubber tube attached to the open end; into this mercury is poured, and that in the bulb is boiled to expel the air, which rises through the mercury in the rubber tube, leaving the upper part of the bulb and glass tube filled with mercurial vapor; as this condenses, the mercury in the rubber tube descends and takes its place; this tube is now removed, the bulb heated, and the open end of the tube is hermetically sealed. The bulb and lower part of the tube are then immersed in the water from melting ice, and afterward in baths at 62° and 92° Fah., and the hight of the mercury marked. The lengths of these spaces are carefully measured, and if they are equal the bore of the tube is assumed to be so, and the length of each degree laid upon the brass scale is the same; if otherwise, by means of a peculiar dividing-engine, they are lengthened or shortened to correspond with the variation of the bore. The figures and letters are next punched, and the plate is passed laterally between rollers to remove the bur left by the tools. It is then silvered and lacquered, the tube attached, and the whole inserted in its japanned case.

As to graduation, the Florentine Academicians took the cold of ice and snow for their zero, and the greatest summer heat of Florence for the upper limit of graduation. These being variable were inefficient.

Boyle suggested a fixed point obtained by thawing oil of anise-seed, as it was, unlike ice, always procurable.

Hooke suggested freezing water as one point.

Halley proposed spirit boiling as another point.

Newton suggested the boiling point of oil, as the range would be so much increased. He next suggested melting ice and boiling water as two points; the interval to be divided into an arbitrary number of degrees which were to be continued up and down. These standards obtained general acceptance.

The use of mercury in the tube was suggested by Halley, about 1697. This fluid is very convenient for the purpose, as having a range of over 700° Fah. between its freezing and boiling points, and expanding very nearly uniformly with equal increments of heat.

Fahrenheit, a native of Dantzic, established as an instrument-maker at Amsterdam, first practically carried out Halley's suggestion. He divided the space between the freezing and boiling points of water into 180°, and commenced the graduation of his scale at the point to which the mercury fell when the bulb was plunged into a mixture of pounded ice and salt; this, producing the greatest degree of cold known to him, he termed zero; and as it corresponded to 32 of the 180 equal spaces between the boiling and freezing points of water, the latter was marked 32°.

Reaumur, about 1730, using spirits of wine, adopted the freezing and boiling points as the two standard points of his scale; the space between these was divided into 80°, and the former was assumed as the zero from which the graduations were extended in each direction De Luc introduced mercury instead of the spirits of wine.

This thermometer was in use in France until the revolution of 1789, but is now generally superseded by the Centigrade.

Celsius, a Swedish astronomer, in 1742 divided the space between the freezing and boiling points into 100°; this thermometer, known in the North of Europe by his name, and elsewhere as the Centigrade, is that in common use on the Continent of Europe, and is very generally employed in scientific investigations elsewhere.

Fahrenheit's is almost wholly confined to the United States, Holland, and to Great Britain and her colonies.

Delisle's thermometer, used to some extent in Russia, has its zero at the boiling-point, and is graduated downwardly, the freezing-point being at 150°.

To find the degrees Fahrenheit corresponding to a given number of degrees Centigrade, multiply by 9, divide by 5, and add 32 to the quotient; thus, $100\ C. \times 9 \div 5 = 180$; $180 + 32 = 212$. By a reversal of the process, that is, by subtracting 32 from Fahrenheit degrees, multiplying by 5, and dividing by 9, we find degrees Centigrade corresponding to those of Fahrenheit; thus, $212 - 32 = 180$; $180 \times 5 \div 9 = 100$. The same rule, using 4 instead of 5, serves to change degrees of Fahrenheit into those of Reaumur and vice versa.

Among the varieties of thermometers may be cited the

*Air*-thermometer; that of Santorio and Boyle. See *ante*, page 53, Fig. 116.

*Balance*-thermometer; an invention of Kewley, by which mercury inclosed in a balanced tube is caused to make one or the other of its ends preponderate, in order to open and close a window or damper. See page 216.

*Barometrical* thermometer; a form of boiling-point apparatus for measuring hights, invented by Dr. F. Wollaston. See HYPSOMETER, Fig 2631, page 1160.

*Chemical* thermometer; one so contrived that its scale is kept out of contact with coloring or corrosive liquids when these are being tested.

*Clinical* thermometer; one used for detecting the heat of the person. It is conveniently constructed to be applied to the surface of the skin, to the axilla, or in the mouth. See *infra;* also page 567.

*Differential* thermometer; records differences, say the maximum and minimum during the period of exposure. See Fig. 1650, page 701.

*Electrical* thermometer; an air-thermometer, designed to show the expansion of air when an electric spark is passed through it.

*Marine* thermometer; one in which the lower part of the tube is protected by curved bars or otherwise, to prevent its being readily broken by rough handling. See Fig. 3064, page 1393.

*Maximum* thermometer; one for recording the highest point attained during an observation. See *infra;* also page 1412.

*Mercurial* thermometer; the common thermometer, in which mercury is the measuring liquid.

*Metalline* thermometer; one depending for its action upon the expansibility of a single metal, or the inequality of expansion of different metals, as Breguet's. See also PYROMETER.

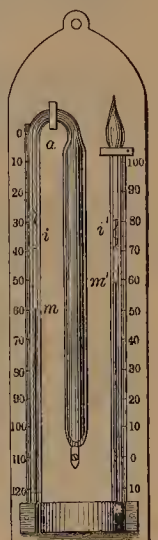
*Minimum* thermometer. See *infra.*

*Registering* thermometer. See SELF-REGISTERING THERMOMETER.

The *self-registering* thermometer is provided with contrivances for indicating the highest or lowest temperatures occurring at times or in situations where it is inconvenient or impracticable to observe them directly. See also page 2092, Fig. 4828; see also THERMOGRAPH; THERMETOGRAPH.

Six's *self-registering* thermometer was invented in 1782, but has since been modified. It registers the maximum and minimum temperature that may occur between observations.

Fig. 6352.




*Six's Register-Thermometer.*

*a* is a long bent tube having a bulb filled with alcohol which reaches to *m*; from this point mercury reaches to *m'*, above which is a second body of alcohol, which expands into an exhausted and hermetically sealed bulb *i i'* are two indexes of steel, covered with glass, and having pellets of enamel at their ends. A bristle is wound around each index, so as to enable it to hold its place in the tube unless in adjusting it for an observation, which is done by a magnet.

In operation, each index is brought down by a magnet, so as to rest upon the surface of the mercury in its own leg of the tube. An increase of temperature after the adjustment will expand the alcohol and raise the index *i'*; should the temperature afterward fall, the index will retain its place, the mercury falling away from it. Should the temperature fall, and the alcohol in bulb *a* contract, the mercury will raise the index *i*, which will cling to the side of the tube, the alcohol flowing past it. Graduations are attached to each leg.

Brookes's *self-registering* thermometer is used in the Greenwich Observatory, England, and consists of a zinc case around the shaft, and a float on the surface of the mercury. On an arm attached to this float is thrown a ray of prepared light, which is thence directed upon a piece of sensitive photographic paper. The paper travels by clock-work, and upon it are shown the variations of temperature, the cross lines on the paper indicating time, as the motion is regular and the rate is known.

A *solid* thermometer, to indicate temperatures higher than

the boiling-point of mercury under one atmosphere (676° Fah.), is called a PYROMETER (which see).

*Spirit*-thermometer; one in which spirit is employed instead of mercury.

*Statical* thermometer; a kind of air-thermometer arranged to open and close a window or ventilator by the expansion and contraction of its contained air. See THERMOSTAT.

For Rutherford's instrument, see THERMEPOGRAPH.

For Beck's instrument, see THERMOGRAPH.

In Phillips's *maximum* thermometer, about ½ inch of mercury at the end of the column is separated from the rest by a minute particle of air. This index is pushed along the tube as the mercury expands, and remains in the same position, when the mercury contracts, thus showing the greatest degree of heat to which the instrument has been exposed. The separated portion is returned to its place by a jerking motion imparted to the thermometer. The instrument, for use, is laid or suspended in a horizontal position.

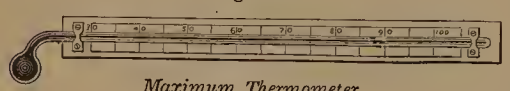
Fig. 6353.

*Twining's Thermometer.*

Twining's maximum thermometer is a spirit-thermometer, having about ½ of the way up the tube a bulbous enlargement in which a globule of mercury is lodged. This permits the spirit to flow past it in expanding, but when it again begins to fall, the globule is carried down with it, becoming elongated in the narrower bore of the tube; this is graduated each way from the bulbous enlargement; the number of degrees indicated by the mercury on the lower scale, added to the temperature shown by the spirit in the upper part of the tube, gives the greatest heat reached.

A recent form of automatic *registering* and *printing* thermometer consists of a glass tube bent in the form of a siphon, the closed leg of which is filled with alcohol and the open one with mercury. On the surface of the mercury in the open end there rests an ivory float suspended from a delicate balance, having platinum wire attached to each end of the lever. When the column of mercury in the thermometer tube rises or falls from the effect of temperature, the platinum wires dip in small mercury cups underneath them, thereby causing a current of electricity to pass through one of two electro-magnets operating mechanism for giving motion to a fine micrometer screw. The motion of this screw elevates or lowers the balance, thereby breaking the circuit. Whenever a change of temperature equal to one tenth of a degree Fahrenheit occurs, the magnetic circuit is completed, and the screw is moved a space equivalent to the change in the hight of the mercury in the thermometer. At the same time the clock-work moves the type-wheels indicating the temperature, which is printed at the end of each hour on a slip of paper moving in front of them. A pencil held against a revolving drum also records a continuous curve, exhibiting at a glance the hight of the thermometer.

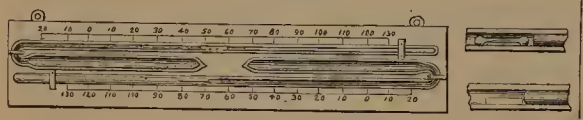
Fig. 6354.



*Maximum Thermometer.*

In Negretti and Zambra's *maximum* thermometer (Fig. 6354) the tube is contracted near the bulb, so that the mercury is not withdrawn into the bulb by contraction, but remains at the maximum indication of temperature reached during its exposure.

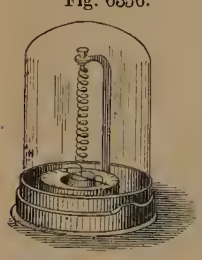
Fig. 6355.



*Self-Registering Thermometer.*

Rutherford's *self-registering* thermometer (Fig. 6355) has a maximum and a minimum tube on the same plate. The first carries a small piece of iron at the end of its mercurial column, pushed forward by expansion, but remaining stationary after the mercury begins to contract; the latter contains spirit, in which is a small index of glass or enamel, shaped like a dumb-bell. This retreats as the fluid contracts, until the lowest temperature is reached, at which point it remains, but permits the fluid to flow past it during expansion.

Fig. 6356.



*Breguet's Thermometer.*

Breguet's thermometer (Fig. 6356) consists of a helix formed by soldering together three strips,—silver, gold, and platinum. The silver, which is most expansible, is placed on the interior, and the platinum, as being least expansible, on the exterior. When the temperature rises the helix unwinds, and as it falls it contracts again, either movement causing an attached needle at the lower end to traverse a graduated arc.

Fig. 6357.

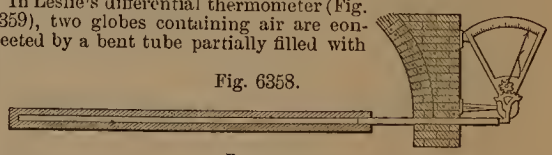
*Dial-Thermometer.*

Fig. 6357 is a dial-thermometer. The case contains a double circularly bent strip of steel and brass, fixed at one end, and having at the other a lever whose longer arm carries a toothed sector working into a pinion, to which a pointer is attached. The unequal expansion of the two metals under changes of temperature causes the pointer to traverse back and forth upon the arc.

Fig. 6358 is Brogniart's *pyrometer*, consisting of an iron bar lying in a groove in a porcelain slab; one end of the slab rests against the bottom of the groove, and the other moves an indicator outside of the furnace. The expansion of the iron by heat is considerable, compared with that of the porcelain, and their difference measures the temperature.

In Leslie's differential thermometer (Fig. 6359), two globes containing air are connected by a bent tube partially filled with

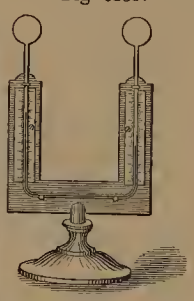
Fig. 6358.



*Pyrometer.*

liquid. When both globes are at the same temperature, the liquid stands at equal hights in each branch of the tube; but if their temperature be unequal, the greater expansion of the air in the more heated globe causes the liquid in the opposite leg to stand at a higher level.

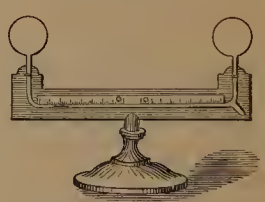
Fig. 6359.



*Leslie's Differential Thermometer.*

Rumford's thermoscope (Fig. 6360) is

Fig. 6360.



*Rumford's Thermoscope.*

analogous to the foregoing, the vertical branches of the tube being shortened. An alcohol index remains at the center or zero of the horizontal tube when the bulbs are of equal temperature, but is pushed toward one or the other end when they differ.

The two latter thermometers do not measure the absolute temperatures, but serve to show the relative differences of heat between two objects in close proximity to each other.

Casella's *minimum* thermometer (Fig. 6361) has near the bulb a curved branch *b* of considerably larger bore than the tube *a*, terminating in a chamber *c d*. The branch *b* has an abrupt shoulder at *d*, and is connected with the chamber by an aperture having

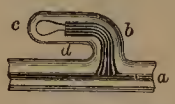
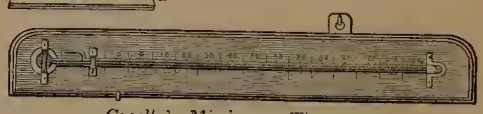



Fig. 6361.



*Casella's Minimum Thermometer.*

a diameter exceeding that of tube *a*. The instrument is adjusted for use by tilting it so as to expel all mercury from the chamber, and suspending it in a horizontal position. The hight of the mercurial column in tube *a* then indicates the temperature of the surrounding air. When the temperature falls, the mercury contracts in the direction of least resistance, along the main tube *a*, the resistance offered by the shoulder *d* preventing its passage into the chamber; but when again expanded by increase of heat, the orifice connecting the tube *b* and the chamber, being larger than the bore of the main tube, offers less resistance than the latter to the passage of the fluid, which consequently flows into the chamber, remaining stationary in the main tube, and indicating the lowest temperature to which the instrument has been exposed.

A very sensitive thermometer is formed by substituting for the ordinary bulb a tube coiled in spiral form, either flat or elongated, thus exposing a large surface of mercury in proportion to its mass to the influence of the external heat.

At the Paris Exhibition of 1862 were exhibited a series of thermometers designed to show the relative absorbent powers

of different colors for radiant heat. These were filled with alcohol tinged of different colors, and when exposed side by side to a common radiant source, all differed from each other; but when removed from the light to an apartment of uniform temperature, their indications exactly coincided.

Fig. 6362.

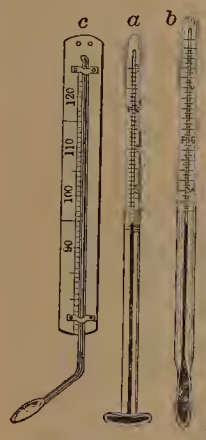
*Coil-Chamber Thermometer.*

Thermometers specially designed for *clinical* purposes have very thin bulbs, in order to render them more sensitive.

*a b* are the *surface* and *fever* thermometers of Dr. Seguin. The former has a flat bulb, and is designed to be applied to the surface of the skin; while the latter may be placed in the axilla or other suitable place, or in one of the natural cavities of the body. The natural temperature of the body is assumed as the zero point of the scale, and the graduations read in each direction from this point.

*c* is Casella's maximum clinical thermometer. It has a globule of mercury serving as an indicator, separated from the mercurial column by an air-space.

Fig. 6363.




*Clinical Thermometers.*

Cripp's continuous self-registering thermometer has a glass bulb, rather more than an inch in diameter, blown on a tube 12 inches long, and having a bore of $\frac{1}{8}$ inch. The tube is then coiled round the bulb in a close spiral, and two needle-pointed pivots are fixed to the bulb. When these pivots are placed in proper upright supports, the thermometer swings freely, like a delicately balanced wheel. Enough spirit is now placed in the thermometer to fill the bulb, and about 4 inches of the tube at 60° Fah. Mercury is introduced until 4 inches of the tube, above the spirit, is filled with it. The spirit is then heated to 120° Fah., which sends the mercury to within one quarter-inch of the extremity, and the tube is then closed, containing of course a minute quantity of air. The whole apparatus is placed in its supports. If the temperature falls and the spirit contracts, the mercury follows it, and the center of gravity is immediately altered. The thermometer accommodates itself to the change by a partial revolution upon its axis, the direction being opposite to that in which the mercury moves. By the simple operation of the two forces heat and gravity, a positive mechanical motion is produced which is transmitted to a minute endless chain placed vertically and carrying a pencil. Facing the pencil is a vertical cylinder moved by clock-work and revolving once in 24 hours. This cylinder carries a strip of paper ruled with one hundred lines one twentieth of an inch apart, and each representing 1° Fah. Across these are twenty-four dark lines for the hours, and lighter ones for the quarters. To prevent friction from the movement of the pencil over the paper, the former is kept constantly one tenth of an inch from the paper, and a small striker taps it every five minutes, or oftener, driving its point against the paper. The movement of the coiled thermometers, and therefore the temperature, is registered by a series of dots.

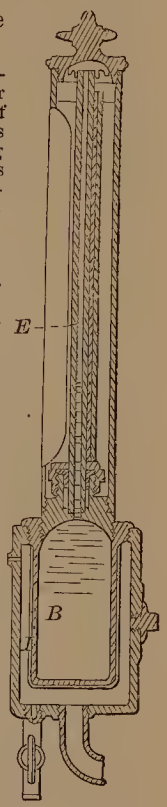
A registering thermometer, designed to measure and register the temperature of ocean depths, of deep borings, or other inaccessible places, or of any locality at any desired time, is composed of a mercurial thermometer, curved in inverted V-shape, and fixed on a scale graduated to Fahrenheit degrees. The cylindrical tube which contains the mercury is slightly bent at the zero point. The instrument is connected with a clock, on the lower portion of the dial of which is a supplementary hand pointing to the numbers 1 to 12. By placing this pointer at any determined number, when that hour is reached the clock-work causes the thermometer to revolve one revolution. The effect of this is to break the mercurial column at the bent portion at 0°, and turn it into the other leg of the tube, where it remains, its hight indicating the temperature at the time for which the dial was previously set.

**Ther'mo-met'ric A-larm'.** An instrument to release an alarm when a dangerous heat is reached in an apartment. A form of *fire-alarm*.

A bent glass tube with a bulb at each end, one of which with a part of the stem contains ether; the other with a part of the stem containing mercury and open to the external air. The tube is poised on its center by gravity. Should the temperature be raised by the presence of fire, the ether would be expanded, the mercury driven into the bulb, the instrument tipped over on its axis, and the alarm sounded. See THERMAL ALARM; THERMO-ELECTRIC ALARM; THERMOSCOPE; THERMOSTATIC ALARM.

**Ther'mo-met'ric Steam-gage.** A steam-gage which indicates the amount of pressure in a boiler by the amount of expansion of a fluid at the temperature due to the pressure.

Fig. 6364.




*Thermometric Steam-Gage.*

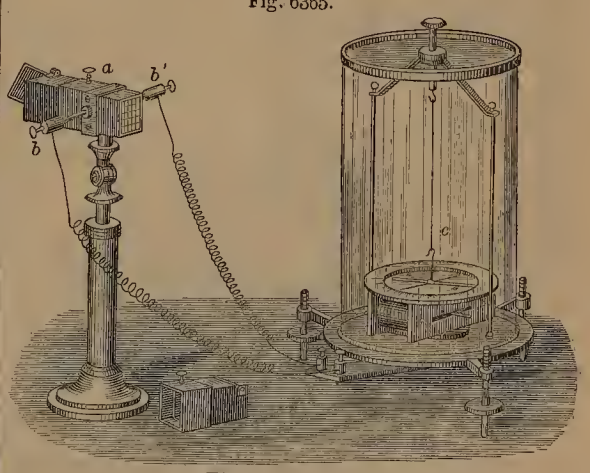
In the example, the reservoir *B*, containing mercury, is inclosed in a steam-chamber *I* connected directly with the steam-space of the boiler. The mercury rises in the glass tube *E*, which has a scale directly indicating the pressure in pounds. The reservoir *B* is coated with copper or other suitable material, to prevent steam from penetrating its walls and condensing inside.

**Ther'mo-met'ric Ven'ti-la-tor.** A modification of Arnott's chimney-valve. It consists of a circular disk, like the throttle-valve of a steam-engine, accurately balanced on a spindle. On one side of the disk is an inverted siphon, with a bulb at one end and open at the other. The lower portion of the siphon-tube contains mercury and the bulb contains air. Any increase of temperature expands the air in the bulb, depresses the mercury, and disturbs the balance of the valve, which opens and allows air to pass. The reverse action takes place when the temperature falls.

**Ther'mo-mul'ti-pli-er.** An instrument invented by Nobili for measuring small variations of temperature due to radiant heat. Its action depends on the fact that thermo-electric currents are developed by two metals whose opposite junctions are exposed to different degrees of heat. The pile employed consists of alternate plates of bismuth and antimony.

As improved by Melloni, these are arranged side by side so as to form a square bundle, the ends of which are the alternate junctions of the elements. These are contained in a copper case *a*, having covers at each end, which may be removed to expose that part to heat. The terminals of the pile are connected by metallic rods *b b'*, with wires leading to a galvanometer *c*. When a beam of radiant heat strikes the pile, an electric current is produced, the amount of which is determined by the galvanometer.

Fig. 6365.




*Thermo-Multiplier.*

**Ther'mo-scope.** An instrument for indicating relative differences of temperature. The term was applied by Count Rumford to an instrument invented

by him, and similar in principle to the differential thermometer of Professor Leslie. See DIFFERENTIAL THERMOMETER. See also Fig. 6360.

Any instrument which shows variations of temperature, whether or not it indicates the actual differences, is sometimes called by this name, including the thermometer. Such were those of Galileo, who in 1593 constructed thermoscopes, which were dependent concurrently on changes of temperature and on variations in the pressure of the external air. These were probably similar to the aërometers of the Spanish Saracens. See AËROMETER.

As early as 1641 observations of temperature were made at regular intervals with spirit-thermometers similar to our own.

Barker and Mayer's thermoscope, August 26, 1873, is designed to indicate in a manner to be readily discernible to the eye the existence of excessive heat in journal-bearings, etc., and also the proper degree of heat to be employed in various processes in the arts. For this purpose two compounds are used The first is produced by adding a solution of copper sulphate, mixed with sulphurous acid, to a clear solution of hydrargyro-iodide of potassium; the resulting red precipitate is washed, dried, and, by means of suitable varnish or other agent, applied directly or mediately to the object. It changes color at about 160° Fah., but resumes its natural color when the temperature is reduced.

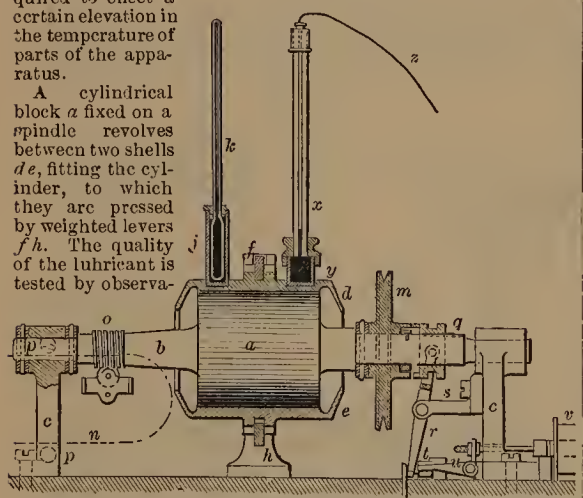
The second is a bright yellow silver precipitate, produced by adding a solution of silver nitrate to the hydrargyro-iodide solution above.

For many purposes the compounds may be applied to cardboard, leather, or thin metal, and by this means attached to the object.

Marcy's thermoscope consists of a thin copper tube of very small bore, and having a bulb at one end. This is inserted within a glass tube, fixed on the periphery of a wheel to which it corresponds in curvature. The tube is hermetically sealed at one end, and in it is poured a certain amount of mercury, which assumes the lowest position in the tube. The axis of the wheel carries a hand which serves as a pointer on a graduated index, and the wheel is balanced on knife-edges. The instrument is particularly designed for experiments on animal heat; the bulb of the copper tube being applied to any part of the body, the contained air expands, displacing the mercury and causing a movement of the index. On being applied to a cooler part, or being cooled by water, the index is caused to move in a reverse direction.

Figs. 6366, 6337, are Stapfer's apparatus for testing lubricants by the number of revolutions required to effect a certain elevation in the temperature of parts of the apparatus.

Fig. 6366.



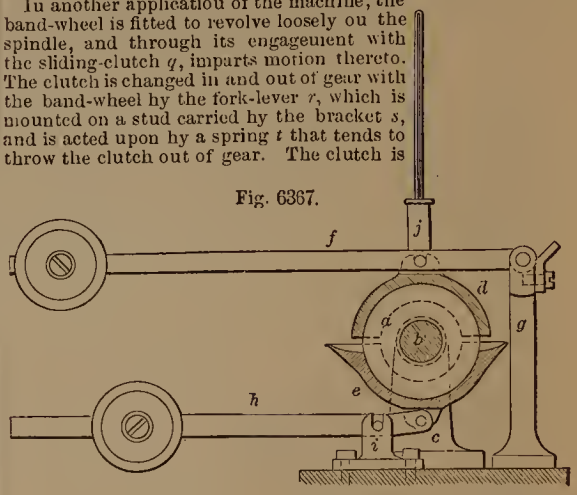

*Stapfer's Apparatus for Testing Lubricants.* (*Side Elevation and Partial Section.*)

A cylindrical block *a* fixed on a spindle revolves between two shells *d e*, fitting the cylinder, to which they are pressed by weighted levers *f h*. The quality of the lubricant is tested by observation of the heat generated by the friction of the opposing surfaces. The upper shell *d* is held down by the weighted lever *f*, which is jointed to the upper end of the standard *g*, the lower shell *e* being pressed upward by the weighted lever *h* that rests upon a fulcrum at *i*. The shells are prevented from revolving with the cylinder by pins in the levers engaging in slots formed in lugs on the shells. A metallic cistern *j* containing mercury is attached to the upper shell, and the bulb of a thermometer *k*, being immersed therein, indicates the temperature to which it has attained.

A band-wheel *m* is mounted on the spindle, and the worm *o* formed on the spindle drives a train in the counter *n*, which registers the number of revolutions. The counter is attached to the standard *c* by two screws, indicated at *p p*.

In another application of the machine, the band-wheel is fitted to revolve loosely on the spindle, and through its engagement with the sliding-clutch *q*, imparts motion thereto. The clutch is changed in and out of gear with the band-wheel by the fork-lever *r*, which is mounted on a stud carried by the bracket *s*, and is acted upon by a spring *t* that tends to throw the clutch out of gear. The clutch is

Fig. 6367.

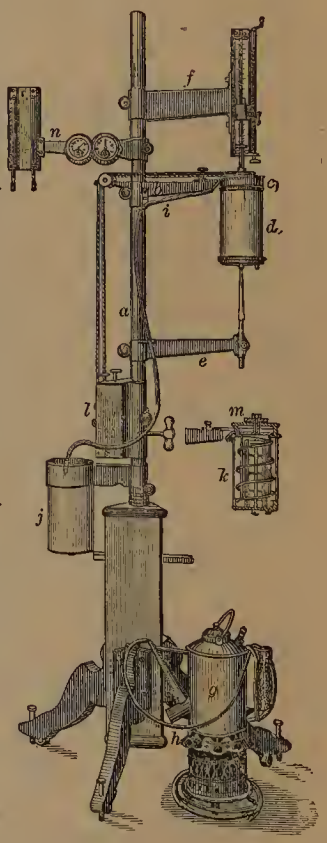



*Stapfer's Lubricant-Tester.* (*Vertical Transverse Section.*)

retained in gear by a catch on one arm of the bell-crank lever *u*, where it engages with a projection on the lever *r*. The other arm of the bell-crank lever is connected with the armature of an electro-magnet *v* in such a manner that so long as the armature is not attracted by the magnet, the clutch remains in gear, and the cylinder *a* consequently continues to revolve. A battery is connected with the magnet and with the upper end of a thermometer *x*, and the glass tube thereof forms a break in the circuit.

The mercury of the thermometer contained in the metallic cistern *y* fixed to the shell *d* rises with the increased temperature of the shell, caused by the loss of the lubricating properties of the oil, until it touches the end of the wire *z* that projects into the tube.

Fig. 6368.




*Osborne's Esthermoscope.*

The mercury then serves to make the circuit, and the armature is attracted, raising the catch from the projection of the lever *r*, and the spring *t* forcing back the said lever, the clutch is thereby disengaged, and the rotation of the cylinder ceases. See also THERMO-ELECTRIC ALARM.

Fig. 6368 is a thermoscope of peculiar construction, for meteorological purposes, the invention of J. W. Osborne of Washington. The object of this instrument is to give expression to the aggregate of all the climatic influences which tend at any time and place to affect the normal temperature of the body, or to modify the demand on it for the physiological production of animal heat. As warm-blooded animals, we are constantly losing just as much heat as we make, and therefore in estimating weather or climate, we speak of it as cold or hot in proportion as it cools us rapidly or slowly, irrespective of the nature of the several causes which determine that cooling. The three great factors which affect us thermically are the actual temperature, the moisture of the air, and its motion as wind over our bodies. The first of these alone is all but universally accepted as indicating relative temperatures affecting animal life. A little reflection will show that it does not do so in reality, playing often quite a subordinate part in determining the sensible heat or cold which we experience. A so-called temperate climate, for instance, will, if windy, cool us faster than a cold and frosty one when perfectly still; and a summer temperature of 90° is fresh and pleasant if dry and breezy, while it is almost unendurable if thoroughly moist and free from wind.

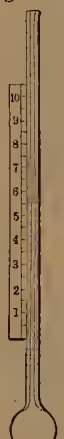
This instrument, shown at Fig. 6368, consists of an upright standard of heavy brass tubing *a*, about six feet high, from which several horizontal brackets extend. One of these *b* carries a ring *c*, from which hangs a cylinder of "boud," or bank-note paper *d*, 100 millimetres diameter, and 150 long (about 4 × 6 inches). The lower end of this is closed by a very thin brass disk, the paper being attached to it and to the ring above by strong rubber bands, or very thin clamping-rings of brass. The arm *e* with the upright wooden pin is used to steady the cylinder when exposed to the wind, or while moving the instrument. The bracket *f* carries a thermometer, the bulb of which is about the center of the cylinder. This cylinder is usually full of cold water, but when an observation is to be made, its temperature is raised to blood heat, or higher, if desired, in the following manner: the copper vessel *g*, being partly filled with hot water, is then elevated above the cylinder, so that the hot water flows in by pipe *h*, and the cold water flows off by the tube *i* into the receptacle *j*. In this way, by simple displacement, any desired temperature can be reached with facility. The cylinder is shown in section at *k*. To maintain the water at an equable temperature throughout, an agitator, consisting of a spiral ribbon, is made to rotate by means of the horizontal pulley *m*, driven by the clock-work *l*, while from the disk below three stationary blades rise perpendicularly, which serve to hold the water from revolving, and force a current to descend the sides and rise in the center against the bulb of the thermometer.

The temperature of the water having been raised to blood heat, or any other point fixed upon, the time in seconds which each degree takes to fall is noted by means of the spring-back stop-watches, on the arm *n* (which also carries the ordinary wet and dry bulb thermometers). These watches are so connected that the movement required to stop one starts the other; whereby a series of intervals can be measured and recorded, each from zero, with perfect accuracy. We thus get the rate of cooling of the mass of water (weighing nearly three pounds) for a series of six or eight degrees, from which a single expression can be calculated.

It will be seen that the cylinder is subjected to influences similar to those which act upon the human body. The paper of which it is made is quite porous, enough to admit of evaporation analogous to that from the skin and lungs. It is cooled by this, and by radiation and convection, as the body is cooled. The rate at which it cools furnishes therefore an expression of the intensity of the aggregate thermal effect, comparable with that experienced by the human body, and proportional for the same or similar instruments at different times and places. The very obvious necessity for the information sought when once pointed out, and the difficulty of obtaining it, give to this invention a peculiar interest.

Fig. 6369 is an instrument devised by Dr. Seguin of New York, to be used in diagnosis. It is intended to detect variations of temperature of the body and the rate of radiation going on therefrom. It consists of a glass tube seven inches long, with a minute bore open at one end, and terminating at the other in a bulb. An adjustable scale is attached to the outside of the tube. To prepare it for use, immerse the bulb in hot water, which rarefies the air inside. The open end is then plunged into cold water and quickly withdrawn, when a drop or two will be found to have entered the tube. This forms a *water index*, which should become stationary within an inch or two of the bulb. If it falls into the bulb, or does not approach it sufficiently, too much or too little heat was applied in the first instance, and it will be necessary to jar the water from the tube and try again. When the index is provided, adjust the scale, bringing its lowest figure on a level with the top of the column of water in the tube, and it is then ready for use. It may be applied to any part of the surface where disturbance of temperature is suspected. It is said to give, by contact, indications of the volume of heat escaping by radiation, and the velocity of loss; and by blowing on the bulb, to indicate the degree of combustion that takes place in the lungs.

Fig. 6369.



*Seguin's Thermoscope.*

**Ther'mo-si'phon.** A siphon attachment to hot-water heating-apparatus, invented by two engineers, — Kewley of London, and Fowler of Devonshire, England. They found that the circulation of the water was greatly increased by passing it through the two legs of a siphon, especially when the tubes were irregular in point of horizontal direction, and both above and below the level of the boiler. See Loudon's "Encyclopædia of Gardening," London, 1834, page 597.

**Ther'mo-stat.** A self-acting apparatus for regulating temperatures.

The balance-thermometer is poised horizontally on an axis, and so arranged that as the mercury contracts or expands in the tube on either side of the mean temperature for which it is adjusted, one end or the other of the thermometer will tip up and actuate a device whereby the heat of an apartment or greenhouse is increased or diminished, as the case may be.

One form was invented by Dr. Cummings of Chester, England, and used to open and shut the windows of hot-houses. A balance-thermometer, patented in England in 1816 by Kewley, was employed to open and shut doors.

An electrical thermostat consists of an ordinary mercurial thermometer, provided with a platinum wire connecting with the mercury in the bulb. Through the other end of the tube is inserted another platinum wire capable of being elevated or depressed. These two wires are in connection with the poles of a battery, and in the circuit is an electro-magnet whose armature controls the opening or closing of a valve for the admission of hot air. If it be desirable that the temperature of the air should not rise above a certain temperature, say 60° Fah., the free end of the movable wire is brought to the required number on the tube. When the heat is such as to cause the mercury to rise to that degree, the electric circuit is completed, the armature closes the hot-air valve until the temperature is diminished, when the circuit is broken, and the valve again opened.

Other forms of thermostat are adapted to open and close the draft openings of furnaces to regulate the admission of fresh air to the fire, and insure a uniformity of combustion.

Dr. Ure, about 1830, contrived a thermostat, the action of which depended on the unequal expansion of two metals by heat, for regulating the safety-valves of steam-engines.

A self-acting statical damper or heat-regulator was invented by Dr. Cummings many years since, and was designed as a mode of opening windows and ventilators in apartments by the variations in the temperature of the included air.

The sash is hung upon centers, so as to oscillate readily, and a cord passes from it to an areometer tube, which is partly charged with quicksilver, and has a body of included air in a bulb at top. The open lower end is plunged in a cup of quicksilver; and as air in the bulb is expanded or contracted by heat, the weight of the suspended tube and bulb becomes relatively less or greater by the variation in the quantity of quicksilver contained, causing the tube to rise or fall, and so operate the sash or valve.

The name *thermostat* was first applied by Dr. Ure to an instrument patented by him in 1831, in which the bending of a spring composed of two unequally expansible metals, as steel and brass, was made to control a valve or damper.

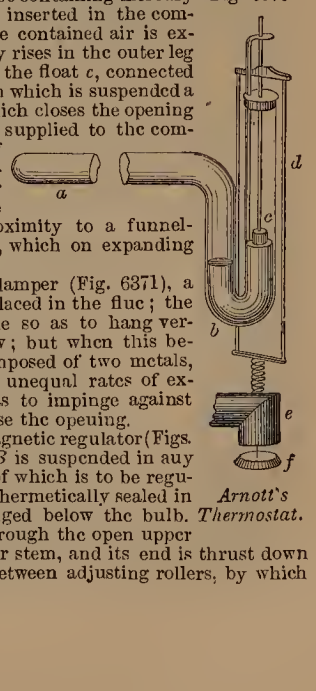
A thermostat was applied by Bonnemain of Paris, in 1777, to his calorifère, by which he heated buildings. The heater consisted of a boiler with an ascending hot-water pipe, which coursed through the stories or apartments of the house, and then descended again to the boiler with its contents comparatively cooled. He heated an incubator in this manner. The variation of temperature seldom exceeded ½° R. See B, Fig. 2666, page 1178.

The thermostat was inserted in the boiler, and acted upon the door of the ash-pit so as to regulate the admission of air to the fire.

It depended upon the unequal dilation of different metals by heat. It was formed of a bar of iron screwed to one of brass, inclosed in a leaden tube terminating in a ring of brass and plunged into the boiler. The dilation of the leaden tube had the effect of drawing upon the rod and bringing the ring in contact with a claw at the short end of a bent lever communicating by a wire with the ash-pit door, which acted as a damper.

Fig. 6370 shows a form applied by Dr. Arnott to his stove. *a b* is a curved tube containing mercury in the bend *b*; the end *a* is inserted in the combustion-chamber, and as the contained air is expanded by heat, the mercury rises in the outer leg of the tube, carrying with it the float *c*, connected by a rod to the frame *d*, from which is suspended a wire carrying the valve *f*, which closes the opening of the pipe *e* by which air is supplied to the combustion-chamber. A fall of temperature produces the reverse effect. In a simpler form, the lower end of the tube *e* is brought into proximity to a funnel-shaped reservoir of mercury, which on expanding by heat closes its mouth.

Fig. 6370




*Arnott's Thermostat.*

In Tamkin's automatic damper (Fig. 6371), a disk turning on an axis is placed in the flue; the disk is weighted on one side so as to hang vertically when the heat is low; but when this becomes excessive, a spring composed of two metals, as copper and iron, having unequal rates of expansion, becomes bent, so as to impinge against the damper and partially close the opening.

In Dr. Sternberg's electro-magnetic regulator (Figs. 6372, 6373), a thermometer *B* is suspended in any apartment the temperature of which is to be regulated. A platinum wire *a* is hermetically sealed in a portion of the tube prolonged below the bulb. An adjustable wire *b* slips through the open upper extremity of the thermometer stem, and its end is thrust down the tube. The wire passes between adjusting rollers, by which

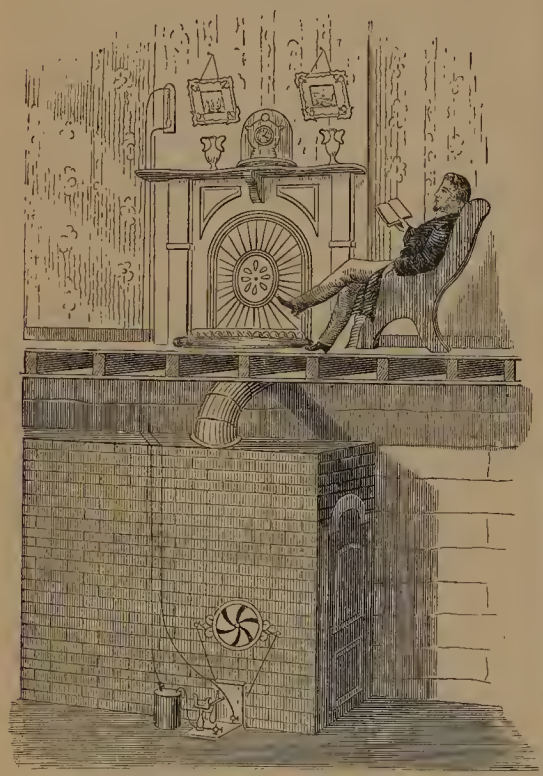
Fig. 6371.

*Tamkin's Automatic Damper.*

it is raised or lowered until its end stands at any desired degree of the scale. By means of binding-screws, the wires *a b* have electric communication with the wires *c d*, which pass to the furnace or heating-apparatus, and are there connected with the apparatus by which the valve or damper is operated. A battery-cup is interposed in the circuit at any convenient locality. When the heat of the room in which the thermometer hangs causes the mercury to rise and meet the point of the adjustable wire, an electric circuit is completed, passing through the helix of a temporary magnet, causing its armature to be attracted, moving a lever by which the valve or damper is closed. This diminishes the heat of the room, and causes the mercury to fall below the point of the wire. The circuit being thus broken, a spring withdraws the armature from the electro magnet and opens the damper.

Pressure of steam may be regulated by making the steam-gage act as a regulator, the electric circuit being made and broken by the needle of the steam-gage dipping in a cup of mercury. This may be arranged either to govern the supply of air admitted to the furnace or a valve by which steam escapes from the boiler. A modification

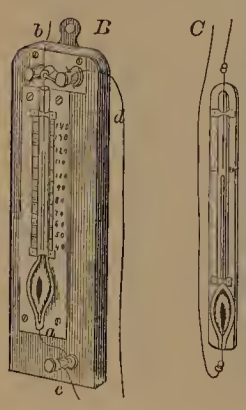
Fig. 6372.



*Sternberg's Electro-Magnetic Regulator.*

of the apparatus, in which the rising and falling of a float opens and closes the circuit, may be employed as a means of controlling the supply-pipe valve of a reservoir.

Fig. 6373.




*Sternberg's Thermometer.*

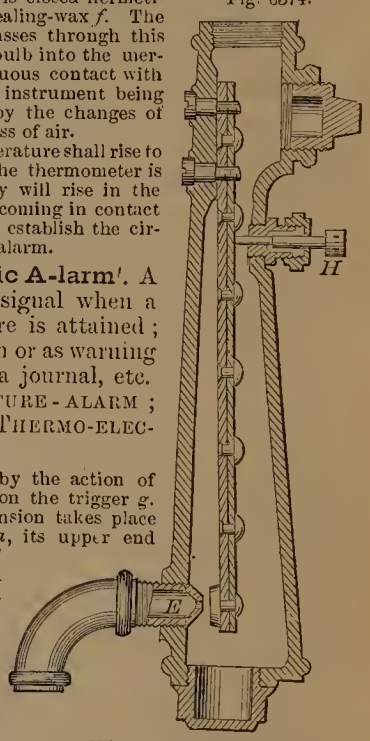
A thermometer (*C*) in which the upper wire is fixed to a certain graduation in the tube is used for immersion into liquids or gases which are to be maintained at a given temperature.

Wilson's thermostat for steam-heaters (Fig. 6374) has a compound plate made of two metals, say of brass and steel, which bends by the unequal expansion of the two metals by increment of heat, and thus stops the steam induction-aperture *E*. *H* is adjusting stop-valve screw.

Watkins combines a compound metallic strip *a* with a closed tubular case *m* by means of an insulating base *b* and a metallic conducting-cap *i* and indicator set-screws *n n*, whereby, by the expansion or contraction of the compound metallic strip, a galvanic circuit may be closed or opened at any required degree of heat to operate a fire-alarm telegraph-instrument.

In Gnest's electrical thermostat (Fig. 6376), the circuit is closed by the rising of a column of mercury in a tube, so as to touch the upper wire *d*. The instrument has a bulb *a* with an expansion-tube *b*, surrounded by an outer vessel *c*, which is closed hermetically by a cork and sealing-wax *f*. The end of the wire *e* passes through this outer vessel and the bulb into the mercury, being in continuous contact with it, the action of the instrument being thus not disturbed by the changes of temperature and access of air.

Fig. 6374.



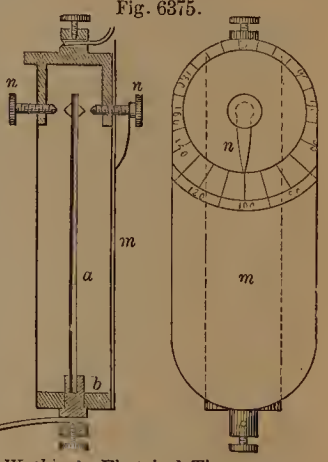

*Wilson's Thermostat.*

Whenever the temperature shall rise to the degree to which the thermometer is adjusted, the mercury will rise in the expansion-tube, and, coming in contact with the wire therein, establish the circuit and produce the alarm.

**Ther'mo-stat'ic A-larm'.** A device to give a signal when a certain temperature is attained; used as a fire-alarm or as warning of the heating of a journal, etc. See TEMPERATURE-ALARM; THERMOSCOPE; THERMO-ELECTRIC ALARM; etc.

Fig. 6377 operates by the action of the thermal bar *a* upon the trigger *g*. Whenever lineal expansion takes place in the thermal bar *a*, its upper end being rigidly fixed to *d* by the screw-threaded shank, such expansion acts directly and entirely upon the lever *e*, and through it upon *f*, causing them to assume the position shown in dotted lines, and releasing *g*. *g* may be the trigger or detent of any suitable alarm-apparatus, releasing a wound-up signal-apparatus, or winding up a signal-apparatus by its movement; or it may be simply a circuit, closing or breaking, serving to separate or bring together the two springs *i* and *k* attached to insulating-blocks *m m*, which springs form the terminals of a battery-circuit, as represented by the wires *p n*, in which circuit is placed any suitable electric apparatus.

Fig. 6375.

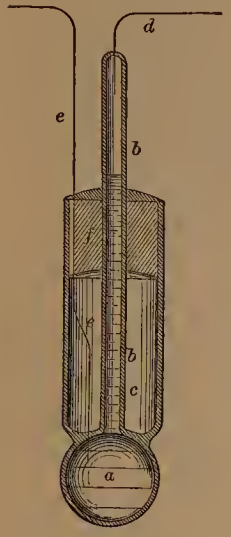



*Watkins's Electrical Thermostat.*

Fig. 6378 shows the application to a portable thermometer of an alarm-bell operated by the closure of an electrical circuit derived from a battery concealed in the base, the circuit being normally open, but closed by the rising of the mercurial column to any predetermined degree of the scale, according to the degree of temperature required. The operation is as follows: the wire *h* is represented as extending down the stem of the thermometer to the point on the scale marked 25°. The mercury in the stem stands at about 15°. While this remains the case the circuit is open, and the armature *m* is not in contact with the poles of the electro-magnet. But when, by reason of increased temperature, the mercury in the stem rises to the point marked 25°, it comes into contact with the end of wire *h* and closes the circuit, which causes the armature *m* to be drawn into contact with the electro-magnet *l* and an alarm to be sounded upon the bell *q* by the hammer *p*. When the temperature falls below 25° the circuit is again broken and the armature is drawn away from the magnet by the spring-arms *n n*. A second hammer, attached to the armature, may be arranged to strike the bell when that fall of temperature occurs. A continuous alarm, if preferred, can be arranged to be operated by the closed current in any of the well-known methods. By sliding the plate *d* up or down, the end of the wire *h* may be made to coincide with any desired point on the scale, and the alarm will be sounded when the temperature reaches that degree.

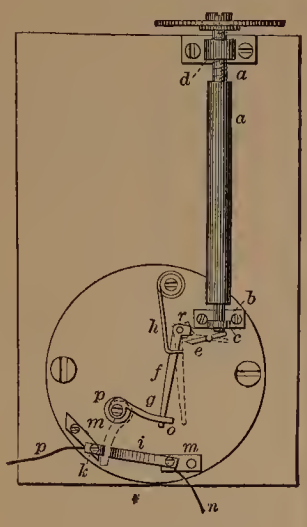
**Ther'mo-type.** An impression (as of a slice of

Fig. 6376.



*Guest's Electrical Thermostat.*

Fig. 6377.



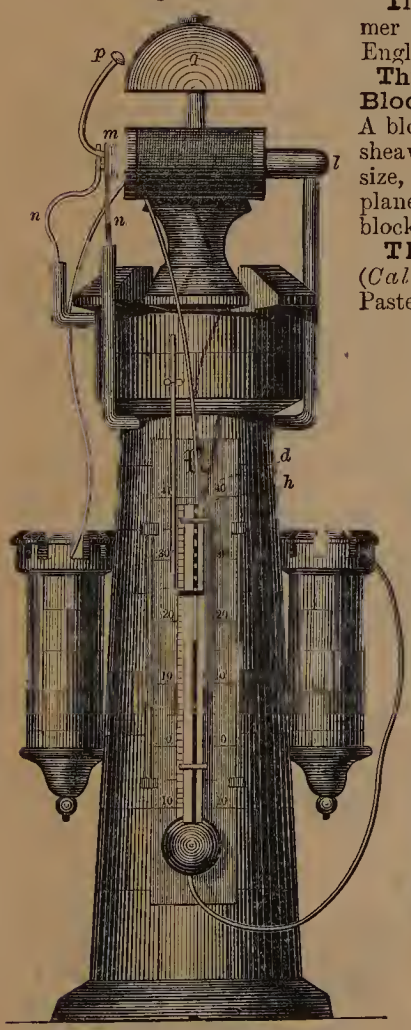
*Guest's Thermostatic Alarm.*

wood) taken by means of wetting with dilute acid, pressing on the object, and subsequently heating the impression.

**Thi'baude.** (*Fabric.*) (Fr.) Cloth made from cow-hair.

**Thib'et-cloth.** (*Fabric.*) A camlet made from goat's hair.

Fig. 6378.



*Snow's Electrical Thermostatic Alarm.*

**Thi'ble.** A skimmer or slice. (Old English.)

**Thick-and-thin Block.** (*Nautical.*) A block having two sheaves of unequal size, in the same plane. A *fiddle-block.*

**Thick'en-ing.** (*Calico-printing.*) Paste which contains the mordant or dye, in some cases, and forming a vehicle therefor.

Fig. 6379.

*Thief-Tube.*

**Thick'ness.** (*Foundry.*) That application of loam in loam-molding which represents the metal, and which is afterward knocked away to leave space for the same.

**Thick'ness-ing.** (*Wood-working.*) Reducing boards or pieces to an even thickness ready for dressing to shape.

**Thick-set.** 1. (*Fabric.*) A stout, twilled, napped cotton cloth. A kind of fustian.

2. (*Husbandry.*) Thorn-bushes used in hedging, in England. The thorn does not succeed so well here. One or two of the American thorns are better here than the English hawthorn, but are far from satisfactory.

**Thick-stuff.** (*Shipbuilding.*) All plank above four inches in thickness.

**Thief-tube.** A tube for withdrawing samples of liquids from casks, etc. A *sampling-tube;* a *vc-linche.* Some *burettes, pipettes* (see Fig. 3750), and *dropping-tubes* are made on this principle.

**Thill.** 1. (*Vehicle.*) A *shaft.* One of the two side pieces by which one horse is hitched to a vehicle.

2. (*Mining.*) The floor of the mine.

**Thill-coup'ling.** A device for fastening the shafts to the fore-axle.

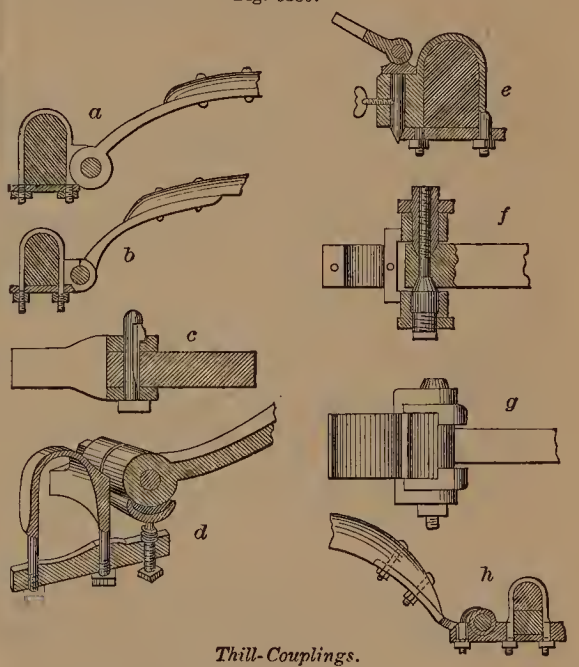
The ordinary mode of coupling (*a*) is by means of a screw-bolt to a clip on the fore-axle. This wears loose and rattles; hence inventions have been brought forward to improve the mode of coupling.

Many patented contrivances, as *b*, depend upon the insertion of a plug behind the pin of the thill, forcing it forward into the hook which is attached to the clip.

*c* consists of a key and spring-latch as a substitute for the screw-bolt, and occupying a similar position, without special adaptation of the other parts.

*d* is Bridget's coupling. The set-screw beneath the socket-plate and elastic pad raises the thill-iron against its pivotal pin and prevents rattling.

Fig. 6380.



*Thill-Couplings.*

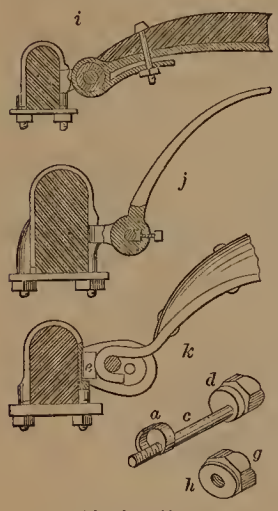
*e.* The thill-iron is swiveled by a cross-bolt in the head of a pin, which is set in a vertical socket in front of the axle-clip, and is clamped by a set-screw.

*f* has conical surfaces on the bolt and its socket, which bear against the sides of the thill-iron and prevent rattling.

*g* is McDermott's; between the jaws of the coupling is a bushing of anti-friction metal provided with a flange, leaving an opening between it and the lug, and with a tubular projection or socket, whereby dirt will find no lodgment and rattling be prevented.

*h*. The clamp-hook or convex-headed cap is situated between the branches of the forked thill-iron, and forms part of a bolt which is secured in the jack by a nut.

Fig. 6381.




*Thill-Couplings.*

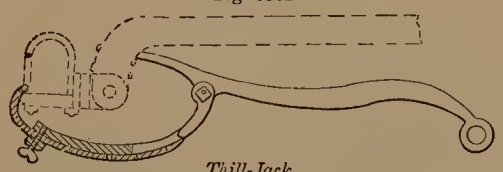
*i*. An open ring bushing is placed around the bolt, and the loop of the thill-iron is bent around the bushing, which may be of raw hide. The end of the iron is bent around and traversed by a temper bolt.

*j*. The head of the thill-iron has a recess opening into the hole through which the bolt passes; in this recess is a friction-plate, which is pressed against the bolt by a set-screw to prevent rattling.

*k*. The thill-hook is placed in the clip, and the bolt inserted. The bolt, being turned half a revolution, brings the eccentric pin *c* against the thill-hook, and forces the latter against an elastic pad *e* in front of the clip. The working faces *a a'* of the bolt turn in the eyes of the clip, as does also the collar *h* of the nut *g*, which prevents the return motion of the bolt.

**Thill-jack**. A tool for attaching the thills of a carriage to the clips of the axle. By means of the lever clamp the rubber, which is placed in contact

Fig. 6382.



*Thill-Jack.*

with the thills to prevent rattling, is compressed, so that the thills may be easily attached. A *shaft-coupling jack*.

**Thill-tug**. A leathern loop depending from the harness saddle to hold the shaft of a carriage.

**Thim'ble**. 1. A frusto-conical metallic sheath used to protect the end of the finger in sewing. Seamstresses use a thimble having a rounded end with numerous small pits or indentations. Those used by tailors, upholsterers, and needle-men generally are open at the end.

The name is said to have been derived from *thumb-bell*, having been first worn on the thumb, as the sailor's thimble still is. It was introduced into England from Holland in 1605, by John Lofting, who manufactured them at Islington.

Thimbles of bronze, exactly like the modern, have been found at Herculaneum.

The thimble is sometimes utilized as a tool-holder. The *extension thimble* of the dentist is a prong on the end of the thimble, used to reach into the mouth to hold the foil or a compress, while operating on the teeth.

The bur thimble has an open ring for the index or middle finger, and a socket attached, in which rests the end of the drill handle.

The *hand-shield* used by sail-makers and saddlers is called a *palm*.

Silver thimbles are made from coin-silver, cast into ingots, and rolled into sheets, from which circular disks are cut by stamping; these are then placed over a circular opening and subjected to the action of a plunger. The end, side, and rim are turned in a lathe, where they are also polished by a round steel rod dipped in oil.

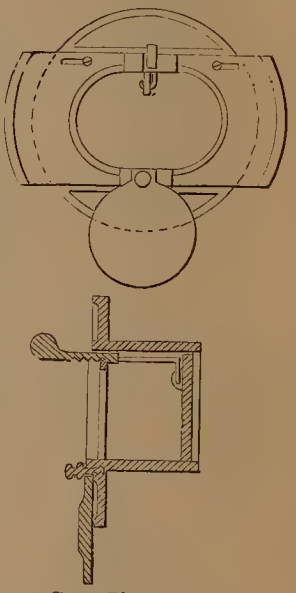
The ornament near the rim is impressed by means of a rapidly revolving steel wheel; a second wheel forms the ornament near the middle. A third wheel provided with points makes the indentations on the side and end. The inside is then polished in a similar way to that employed for the outside. The thimbles are finally boiled in soapsuds to remove the oil, and then brushed.

Iron thimbles for sewing are *raised* by stamping with five or six blows, between as many pairs of conical dies, which are successively more and more salient. The metal is annealed between each operation.

In Paris they are made from strips of thin sheet-iron, which is punched into disks about two inches in diameter; these are heated red-hot, struck up to the required depth, then placed in the lathe, where the interior is polished, the outside turned off, the pits indented with a kind of milling tool, and a groove formed on the outside to receive the gilding. After being annealed and brightened, the inside is also gilt with a strip of gold-leaf applied by the pressure of a mandrel. A fillet of gold-leaf is similarly secured in the exterior groove.

2. (*Nautical.*) An iron ring having an exterior groove worked into a rope or sail, for the purpose of receiving another rope or a lanyard. A large eyelet.

Fig. 6383.



*Stove-Pipe Thimble.*

3. (*Machinery.*) *a*. A sleeve or tube through which a bolt passes, and which may act as a stay.

*b*. A ferrule to expand a tube; specifically, a ferrule for boiler-tubes.

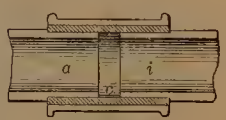
4. A sleeve around a stove-pipe when it passes through a wall or ceiling. In Fig. 6383, the sliding-jaws in the face are capable of embracing pipes of varying sizes, and the opening is closed by a shutter; a damper is placed in the rear end.

**Thim'ble-eye**. (*Nautical.*) An eye in a plate through which a rope is rove without a sheave. A *dead-eye*.

**Thim'ble-joint**. A sleeve-joint, with an interior packing to keep the joints of pipes tight during expansion and contraction.

The adjoining ends of the pipes *a i* are turned true on the outside, and have a thimble, or short cylinder of wrought-iron, to inclose them, leaving only a small space for the current. A piece of tin *c*, or inner thimble, is interposed, and made to fit well to the turned parts of the pipes, which, under the influence of heat or cold, work forward or backward, like a piston in a cylinder. In a range of pipes 120 feet in length, there is a motion from expansion of three quarters of an inch; but the usual allowance for the expansion of cast-iron pipes is one eighth of an inch in 10 feet, or $\frac{1}{960}$ of their length.

Fig. 6384.



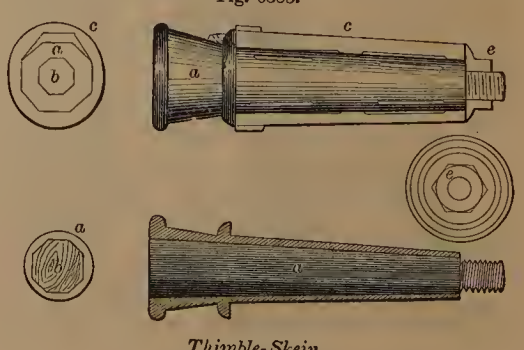

*Thimble-Joint.*

**Thim'ble-skein**. (*Vehicle.*) A sleeve over the arm of a wagon-axle; distinguished from a *strap-skein*, which is simply a flat iron strip let into the wood of the axle-arm to take the wear from the wood. See also AXLE.

In Fig. 6385, *a* shows a thimble-skein; *b*, the wood of the axle-arm, over which the skein is slipped; *c*, the box of the hub; *e*, the nut on the screw at the end of the skein.

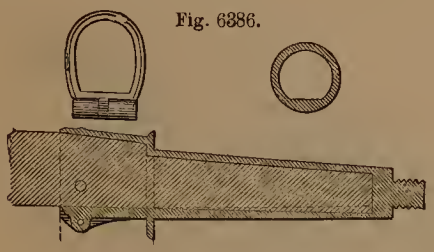
The thimble-skein (Fig. 6386), at its lower bearing surface, has a flat straight seat for the under side of the wooden axle,

Fig. 6385.




*Thimble-Skein.*

Fig. 6386.



*Snyder's Thimble-Skein.*

and has a gradual taper from its front to its rear end to facilitate fitting to the axle.

**Thirl'ing.** (*Mining.*) A worked space connecting the *rooms* of a mine. The *rooms* are galleries proceeding regularly — in coal-mines — from the *dip-head* or *main-level*, and the unworked space forms a *wall*. By cutting gaps in this *wall* at regular intervals, the *wall* becomes a row of *pillars*, the said connecting workings are *thirlings*.

**Thir'ty-two.** (*Printing.*) A sheet of paper which folds up into 32 leaves or 64 pages. Usually written 32mo.

**This'tle-dig'ger.** A long narrow spade for cutting the roots of thistles below the crown of the root, and lifting them from the ground. See Fig. 5334, page 2251.

**Thole.** 1. (*Nautical.*) A pin inserted in the gunwale of a boat to serve as a fulcrum for the oar in rowing. They are arranged in pairs, the space between forming one kind of rowlock. Tholes are shown on the gunwales of ancient Assyrian boats. (Rawlinson's "Five Great Empires," Vol. 1. page 550.) Called also *thowls*, *tho'e-pins*. See Row-lock ; also Fig. 3360, page 1542.

2. (*Husbandry.*) The *nib*, pin, or handle of a scythe-snath.

3. (*Architecture.*) *a.* The scutcheon or knot at the center of a timber-vault.

*b.* A place in temples where votive offerings were suspended.

**Tho'lo-bate.** (*Architecture.*) A cupola, and a base ; that part of a building on which a cupola is placed.

**Tho'lus.** (*Architecture.*) An appellation given to buildings of a circular form. Vitruvius uses it to signify the roof of a circular building. Now frequently applied to the *lantern* which surmounts a dome.

**Thong.** A leathern strap or lash.

**Tho'ra-co-sco'pi-um.** (*Surgical.*) A Stethoscope (which see).

**Tho'ri-um.** A heavy gray metal which burns when heated in the air.

**Thor'ough-bolt.** (*Shipbuilding.*) A bolt going through from side to side.

**Thor'ough-brace.** (*Vehicle.*) A strong band or thong extending from the front to the back C-spring and supporting the body.

**Thowl.** See Thole.

**Thrash'ing-ma-chine'.** (*Husbandry.*) One for beating out grain from the heads. The normal form operates upon wheat, barley, oats, rye, and timothy. Some modifications have been made for flax and clover-seed.

In Egypt, the ancient modes of thrashing have been maintained till modern times. (See Fig. 4196.) Their wheat was bearded.

"For the fitches are not thrashed with a thrashing instrument, neither is a cart-wheel turned about upon the cummin ; but the fitches are beaten out with a staff, and the cummin with a rod. Bread-corn is bruised ; because he will not ever be thrashing it, nor break it with the wheel of his cart, nor bruise it with his horsemen." — Isaiah xxviii. 27, 28.

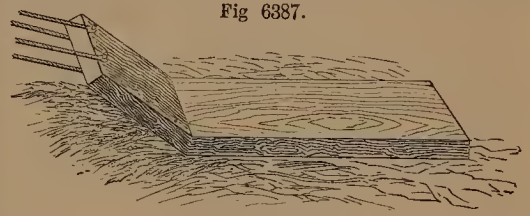
We learn from Amos that the sheaves were carted to the floor. Four instruments of thrashing are mentioned in this passage, — the *flail*, the *drag*, the *wain*, and *treading by cattle*. Another, not mentioned, was the *ripple ;* doura, sorghum, or flax was thrashed by drawing across a comb-like instrument. See Fig. 4341.

The practice was, and is, to gather the grain to a spot which is exposed to the wind, and there lay floors of sheaves about a foot thick. As the grain in the sheaf is thrashed, it is heaped in the center of the circular track on which the operation is performed, awaiting a favorable day for winnowing.

Barley harvest preceded that of wheat in Egypt and Palestine, and Boaz winnowed barley at his thrashing-floor when Ruth waited upon him.

1. The thrashing by flails was adopted for the more tender kinds of grain.

Fig 6387.

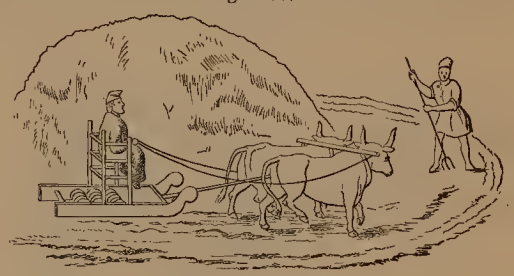


*Syrian Mowrej.*

2 The drag was a frame of wood shod with iron (or sharp pieces of lava in Palestine) ; it was sometimes toothed, making it "a new, sharp thrashing instrument, having teeth." (Isaiah xli. 15 ) This may have resembled the Roman tribulum, which was a sled drawn by oxen. The driver rode upon it.

3. The *wain* was a frame with a number of axles on which were placed gangs of wheels. It was drawn by oxen around the track on which the sheaves were laid. A man attended with a

Fig. 6388.



*Egyptian Mowrej.*

fork to throw in the unthrashed straws and keep a full thickness on the floor beneath the thrasher. Niebuhr and Thompson have described the process at length. It is as it has always been since the first record of such things.

Varro (150 B. C.) describes a Carthaginian machine which traveled on rollers studded with iron knobs and having a seat for the driver.

4. The tramping by cattle needs no particular description. The Hebrew law forbade the muzzling of the mouth of oxen while trampling out the corn.

Fig. 6389.

*Tramping out Grain in Egypt.*

Dr. Thompson considers the thrasher made of a slab, studded beneath, to be the common form of machine, and states that it grinds the straw up into chaff; the latter makes the winter feed of the animals, who know not hay. The arrangements were similar when Gideon thrashed wheat by the wine-press under the oak in Ophrah, 1249 B. C. ; and when the plague was staved at the thrashing-floor of Ornan the Jebusite (1017 B C.), at the elevated spot afterward known as the hill of Zion, and which was purchased by David for 600 shekels of gold as a site for the temple his son Solomon was to build.

Among the Romans thrashing was carried on in similar ways ; —

1. The ears or the grain in the straw, as it came from the field, was thrashed by the *flail ;*

2. Or trodden out by men or horses ;

3. Thrashed by a *tribulum*, a loaded board shod with iron bars and drawn by oxen;

4. Thrashed by a *Punic wain*, a frame supporting a rider and running on toothed rollers.

Virgil recommends that the thrashing-floors be spaded up and rammed down with chalk and cow-dung. Pliny advises lime slacked with the amurca of the olive to make a cement floor. Cow-dung and the marc of olives are still used in France for preparing thrashing-floors.

Fig. 6390.

*Roller for Thrashing.*

Thrashing in Lombardy is generally performed by means of a fluted roller (Fig. 6390) drawn around in a circular track.

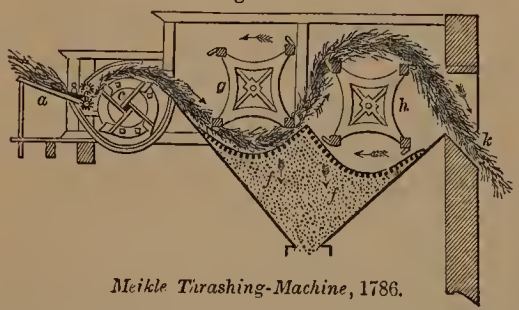
Hohlfield of Hermerndorf, in Saxony, 1711-1771, invented a thrashing-machine while working on the estate of Gusow, in the service of the Prussian minister, Count de Podervils. We are not informed as to its construction; it seems to have given satisfaction. He also invented a straw-chopper and many other machines.

Menzies made a machine in Scotland in 1732, and Stirling of Dumblane another in 1758, but they do not seem to have been successes.

Meikle, of Tyningham, East Lothian, Scotland, invented a machine in 1786, which is the type of modern thrashers. Menzies's had a series of revolving flails, and Stirling's had a cylinder with arms upon a vertical shaft running at high velocity. Meikle invented the drum with beaters acting upon the grain in the sheaf, which was fed between rollers. The English improvement was to make the beating drum work in a concave known as the *breasting*, the grain and straw being scutched and rubbed between the two and carried to the shaker, which removed the straw from the grain and chaff, a large amount of grain also falling through the bars of the concave.

Fig. 6391 shows the Meikle machine, in which the grain in the straw is fed from the board *a* between two fluted rollers to the beater-cylinder *c*; thence passes to another beating-cylinder *g*, which operates above a concave grating; a third cylinder *h*

Fig. 6391.




*Meikle Thrashing-Machine*, 1786.

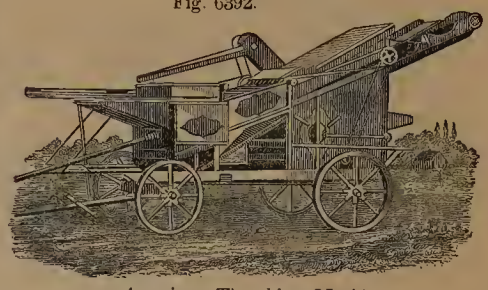
raises and loosens the straw, which parts with its grain *f* through the concaves, and the straw is delivered at *k*. The circular rakes *g* and *h* were added in 1789 by Chillingham. In 1800, the fanning-mill was added.

The American improvement upon this consists mainly — besides numerous details which secure speed, lightness, and effectiveness — in having, upon the drum, spikes or teeth which pass between fixed spikes on the concave; the grain in the straw being subjected to a severe beating and rubbing action as it passes in a zigzag course between the two, being carried by the teeth of the drum. The latter is now usually a skeleton cylinder of iron bars with sword-shaped spikes secured by threaded tangs and nuts. The front edges of the spikes are rounded and smooth, to prevent breaking of the grain; the spikes of the concave have smooth edges presented toward the coming grain for a similar reason. The English still adhere to the flat beaters, like narrow wings or slats, placed longitudinally, and with edges projecting outwardly from the drum. The Americans adhere to the spiked cylinder. A fair trial between the two was had on the farm of Mr. Mechi, Tiptree Hall, Kelvedon, England, in 1853. The American machine was operated by the two persons who had shipped it from the United States; one of them was the present writer. The trial was conclusive. The American machine was driven by a portable engine of six horse-power, and averaged 64 bushels of wheat per hour; 448 bushels of barley were thrashed in six hours, nearly treble the work of the English competing machines, and the grain in much cleaner condition.

The editor of the London "Times," Mr. Mowbray Morris, himself witnessed the operation, and wrote as follows in an editorial of the following day, November 1, 1853: —

"The machine, which is portable, weighs only fourteen hundred-weight,

Fig. 6392.



*American Thrashing-Machine.*

thrashes easily, and without waste, at the rate of one bushel in forty seconds, and turns out the grain perfectly clean and ready for market. It is therefore about twice as light in draught as the lightest of our machines of the same description: does as much if not more work than the best of them, and, with much less power, dresses the grain, which they do not, and can be profitably disposed of at less money than our implement-makers charge. . . . . We build thrashing-machines strong and dear enough, and tremendously heavy either to work or to draw. The American farmer demands and gets a machine which does not ruin him to buy or his horse to pull about, which runs on coach and not wagon wheels, and which, without breaking the heart of the power that drives it, yields the largest and most satisfactory results. Nothing, therefore, can better illustrate the difference in mechanical genius in the two countries than this grain-separator as compared with its British rivals."

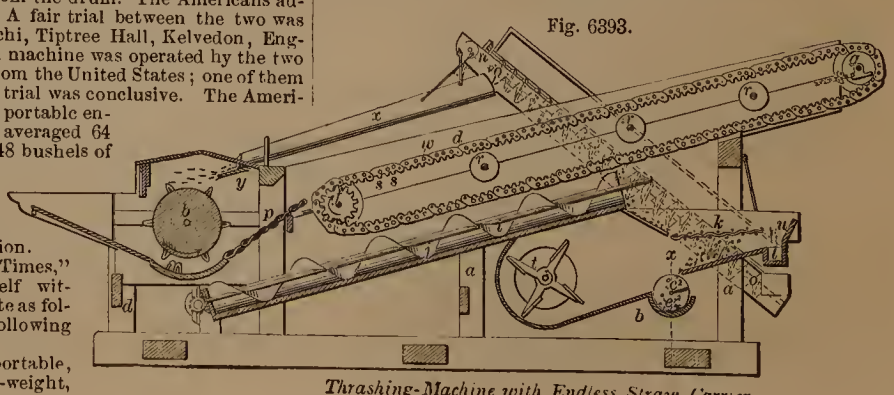
It may be mentioned that the apparent perversity with which the British retain flat beaters instead of the teeth is that in many parts of Britain there is a profitable market for trussed straw; the straw is less broken by the beaters than by the teeth, is in more unbroken lengths, and trusses more readily and handsomely.

The American thrashing-machine has some characteristics common to nearly all its machines. An inclined chute furnishes the sheaf, heads foremost, to the action of the radial teeth that are attached to the skeleton cylinder, and are opposed to the teeth in the concave plates beneath. A straw-carrier elevates and discharges the straw, shaking out the grain, which falls into the well. A lifting screw elevates and forwards the grain and chaff from the well to the vibrating shoe that carries the dividing screens, which, with the aid of the blast from the fan in its rear, separates the grain from its accompanying refuse. The clean grain then falls into a forwarding screw that discharges through a spout into a measure or bag.

An elevator returns the tailings and unthrashed heads to the cylinder to be worked over. An endless belt furnished with transverse slats, and sometimes covered with an apron, takes the straw from the machine. Some machines are also provided with a straw-carrier that elevates and forwards the straw, commonly discharging it on the stack, as seen in Fig. 2570, page 1126. See also STRAW-CARRIER.

The machine (Fig. 6393) has a thrashing-cylinder *b*, a grating *p*, a slatted straw-carrier *w d*, which has cogs *s s* beneath it to shake it as it passes over the rollers *r r*. The straw-carrier is driven by a pinion *f* from the side gearing, and the carrier is

Fig. 6393.




*Thrashing-Machine with Endless Straw-Carrier.*

tightened by the shiftable roller *g*. Grain is lifted from the well by the conveyor *i j* and discharged on to the screen *k*, where the blast from the fan *t* meets it and blows the chaff over the end of the shoe, the grain falling into the concave *b*, whence it is removed by the screw conveyor *x*, which is axled on *c*. Heavy tailings fall inside the board *u*, and are caught in the tray *l*, discharged into the box *o*, raised by the conveyor *n*, and discharged by the spout *x y* into the cylinder case. *a a* are the stanchions of the machine.

In Fig. 6394, the features are similar in most respects, but differ in the shape somewhat. It also has a beating-cylinder to lighten up the straw as it comes from the thrashing-cylinder, to allow the grain to fall out. The straw-carrier consists of suspended oscillating frames with teeth; these move in two gangs, one set alternating with the other, and shoving the straw forward step by step.

The English thrashing-machines are driven by engines of from 4 to 6 horse-power. The feeding-rollers are 3½ inches in diameter, and make 35 revolutions per minute. The straw-rakes have the same diameter, and make 30 revolutions per minute. The drum has beaters, formed by slats on the ends of radial arms, differing in that respect from the American thrashing-machines, which usually have skeleton-cylinders armed with radial teeth. The mode of feeding in the English machines also differs from ours. The sheaf, with us, after cutting the band, is spread upon the inclined feed-chute by the person who is feeding, and passed gradually into the throat of the machine, head ends first. In some of the English machines, the straw is fed in broadside on, to prevent the breaking of the straw; by this means, only a part of each beater acts upon the ears. Other machines, as above remarked, have rollers which carry the grain in the straw from the feed-board to the thrashing-cylinder.

The diameter of the English drum is 3½ feet, and it makes 300 revolutions per minute. While it has nearly double the diameter of our thrashing-cylinder, it has only about one fourth of the number of revolutions. The space, therefore, is about

the same. The American thrasher is more expeditious than the English, does its work as thoroughly, and cleans the grain as well. It is lighter, cheaper, and requires less power for a given amount of work performed.

Fig. 6396 is a longitudinal sectional view of an English form of thrashing-machine in which the opened sheaves are fed between a beater-cylinder and concave; delivered on to an elevator consisting of a number of narrow belts with spikes; thence to a second elevator, the grain and chaff meanwhile falling in a shower upon the shaking shoe beneath, where, by means of riddles and blast, they are separated. The straw is delivered at the rear of the machine to a fan and spout, which carry it away and deliver it on to a stack. The shoe delivers the grain into sacks at *a*, the tailings fall into a pile at *b*, and the chaff at *c*.

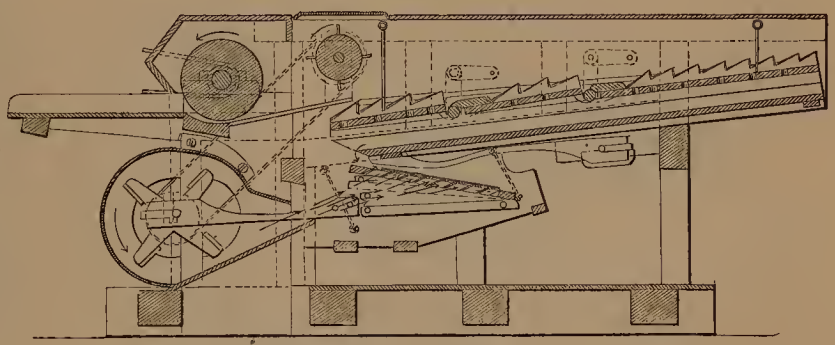
The thrashing-machine of Sir W. W. Wynne, at Wynnstay, Britain, is perhaps one of the most complete of which we have any account. An elaborate description of it, illustrated by cuts, is given in the supplement to Loudon's "Cyclopædia of Agriculture," London.

It separates the grain from the straw, and delivers each into its proper place without any other attention than feeding. The barn is on a declivity, and has three stories. The sheaves are carried into the upper one, where the thrasher is situated. On the second floor is the first winnower and chaff-house, communicating with the straw-house and cattle-yard. On the lower floor is the second winnower and the foot of the elevators, which raise the grain for distribution to the granaries, to the bruisers, which fit it for feed.

It is driven by an overshot water-wheel 18 feet in diameter, 4 feet wide.

Cresy gives the quantity of wheat thrashed and cleaned by the English machines as from 12 to 24 bushels per hour. This is not over one third of the work performed by an American

Fig. 6394.

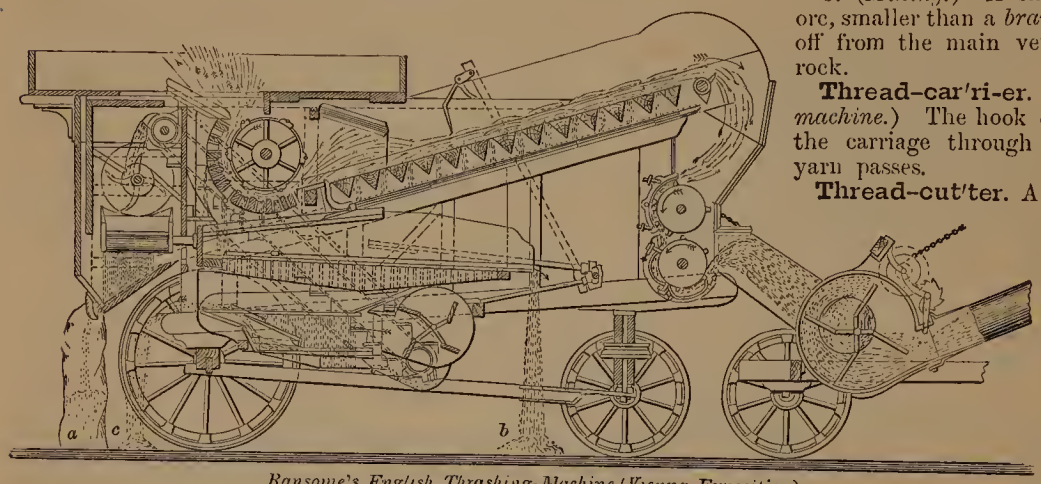


*Thrashing-Machine with Oscillating Straw-Carrier.*

Fig. 6395.

*English Thrashing-Machine and Portable Engine.*

Fig. 6396.




*Ransome's English Thrashing-Machine (Vienna Exposition).*

machine of good quality, on reasonably good wheat. Perhaps Cresy's figures are not up to the present mark.

**Thread.** 1. In the manufacturer's language, thread is a compound cord consisting of two or more single yarns, doubled and twisted.

In the trade it is divided into

*Lace* thread.
*Stocking* thread.
*Sewing* thread.

*Lace* thread consists of two yarns, Nos. 140 to 350, twisted together.

*Stocking* thread varies in the number of its yarns.

*Sewing* thread consists of three or more yarns united and intertwisted.

The doubling and twisting of thread is effected by spindles and flyers operating in a manner similar to the THROSTLE (which see). The twist is usually in a direction the reverse of that given to the individual yarns.

Thread of fine quality was imported into England from Holland and Flanders for many centuries. The thread for making the Honiton (Devonshire, England) lace was imported from Antwerp.

Long-fibered cotton, as "Sea Island," or Egyptian, is best adapted for making thread. Sewing-thread undergoes the following operations in the process of manufacture: —

1. It is passed through a picker, which separates and arranges the fibers. 2. The carding-machine straightens the fibers and coils the roving or sliver into a can. 3. The combing-machine separates the short fibers, the long ones only being used in forming the thread. 4. The fiber is united, drawn out, reduced, and partially twisted, previous to spinning. 5. The rovings are spun into a very fine thread upon the mule, and wound upon bobbins. 6. When the bobbins are full, they are transferred to the winding-machine, where the threads are wound off, two together, on to other bobbins. 7. These bobbins are taken to the twisting-machine, where the two threads are twisted tightly together and wound upon bobbins again. 8. Three of these doubled threads are wound off as before. 9. They are twisted together, forming a compound thread consisting of six strands or yarns.

The thread thus made is reeled off, tied up into hanks or bunches, and taken to the bleachery, where it passes through the processes of boiling, bleaching, washing, soaping, bluing, and drying; or to the dye-house, where it is thoroughly boiled and prepared, and colored by various dyes. After bleaching or dyeing, the hanks are again returned to the mill and wound upon large bobbins, from whence the thread is wound on the small spools for market.

The spooling-machines automatically wind the thread on the spool, cut the nick, insert and fasten the end of the thread, cut it off, draw the spool off the spindle, drop it into a hopper, replace it by another spool, and continue the winding. Each machine winds eight spools at a time, at the rate of 300 dozen per day.

The thread and gauze manufacture was begun at Paisley, in Scotland, 1759.

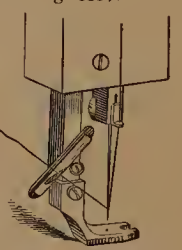
2. The spiral projecting rib on the shaft of a screw.

3. (*Mining.*) A slight vein of ore, smaller than a *branch*, passing off from the main vein into the rock.

**Thread-car'ri-er.** (*Knitting-machine.*) The hook or eyelet on the carriage through which the yarn passes.

**Thread-cut'ter.** A small blade attached to a thimble, to a thread-stand, or to a sewing-machine, to cut off a sewing-thread; a substitute for breaking it, or for a pair of scissors. See list, page 2112, SEWING-MACHINE, Class F, section 26.

Fig. 6397.



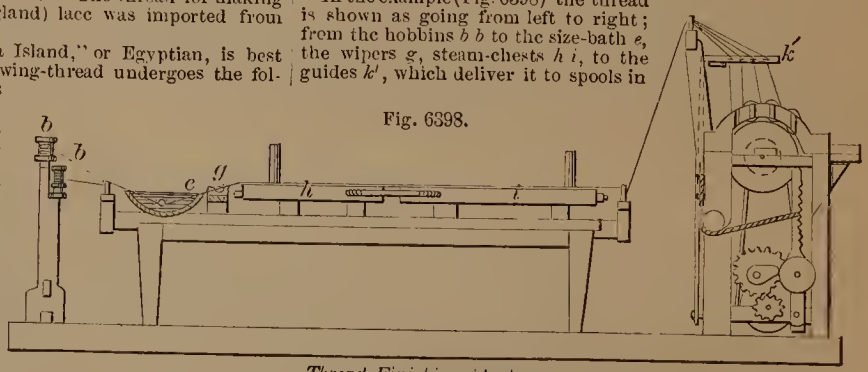
*Thread-Cutter.*

**Thread'er.** A device for guiding the thread into the eye of a needle. See NEEDLE-THREADER, Figs. 3312, 3314, page 1520; also list under SEWING-MACHINE, Class F, section 8, page 2111.

**Thread-fin'ish-er.** A machine in which thread is treated to give it a smooth and polished surface. It usually consists of a sizing and drying operation, which smooths down the fluff of the fiber and imparts a hard, glossy surface.

In the example (Fig. 6398) the thread is shown as going from left to right; from the bobbins *b b* to the size-bath *e*, the wipers *g*, steam-chests *h i*, to the guides *k'*, which deliver it to spools in the winding-frame on the right.

Fig. 6398.




*Thread-Finishing Machine.*

In Fig 6399, the thread proceeds from the spools on stand *W* by a guide *j*, thence is coiled around the rollers *d d*, which are in a frame having a horizontal reciprocating motion to rub the threads, in order to harden and round and at the same time rub the fluff from the thread. It then passes by a reciprocating guide-bar *p* to the receiving-spool *N*. See also THREAD-FRAME; THREAD-POLISHER.

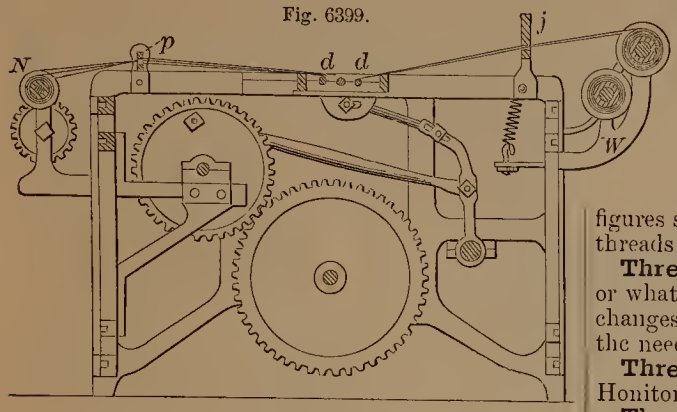
**Thread-frame.** The doubling and twisting mill by which two or more yarns are combined to form a thread. The yarns as they are unwound from the bobbins or cops are passed beneath the surface of a solution of gum or starch in a trough *a* (Fig. 6400); the wetting enables them to be condensed into a more solid thread; they then pass between rollers *b*, by which they are laid parallel, or nearly so, and are thence conducted to the flyer *c*, by which they are twisted together, and to the bobbin, on which they are wound.

Fig. 6401 shows a machine similar to the throstle, by which

doubling and twisting cotton or linen yarn to form thread is performed.

The view is a transverse section of the machine. *a* is the cast-iron frame; *b*, the *creel* on which the bobbins *c c* are loosely

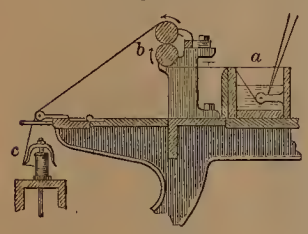
Fig. 6399.




*Thread-Finishing Machine.*

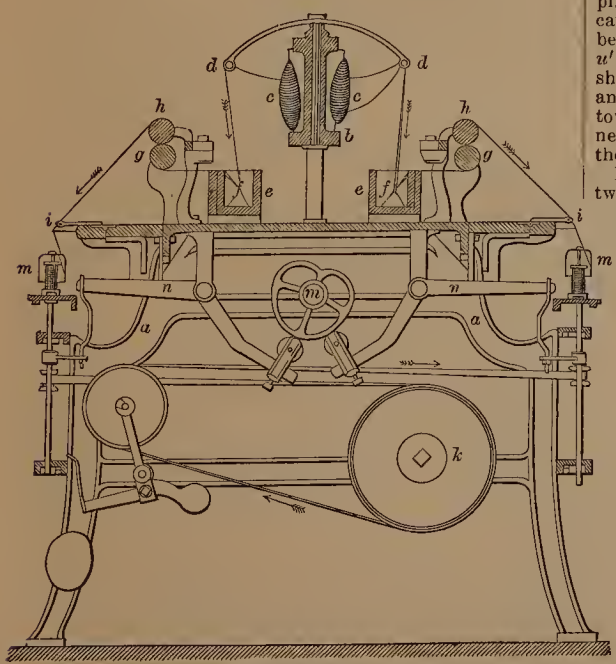
supported along the whole line of the machine, their lower ends turning in oiled steps, and their upper ends in wire eyes *d d* are glass rods over which the yarn winds as it is unrolled; *e e*, oblong narrow troughs, lined with lead and filled with water, through which the thread passes to moisten it, being drawn through eyes at the bottoms of the forks *f f*, which may be lifted out of the trough. *g g* are smooth rollers of iron, and *h h* rollers of boxwood, between which the thread is pressed. The thread passes from the bobbins *c c* over the rods *d d*, thence downward beneath the forks *f f*, under the rollers *g g*, and upward between them and the rollers *h h*, thence downwardly through eyes *i i* to the bobbins *m m*, by which it is twisted and on which it is wound. The rollers *g* are turned by gearing, and turn the rollers *h* by friction. The spindles are driven from the drum *k* by a band passing over the pulley *l*, weighted to keep the pulleys tense. The bobbins are traversed vertically to wind the thread evenly upon them by a gear on the end of one of the lower roller-shafts, which turns a carrier-wheel engaging a wheel on the shaft carrying the heart-cam *m*; this operates the levers *n n*, raising and lowering the bobbins. See also THREAD-POLISHER.

Fig. 6400.




*Thread-Frame.*

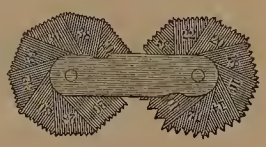
Fig. 6401.




*Thread-Frame.*

**Thread-gage.** A gage for determining the number of threads to the inch on screws and taps. It consists of a number of toothed plates turning on a common pivot, so that the serrated edge of each may be applied to the screw until one is found which corresponds therewith. The figures stamped on the plate indicate the number of threads to the inch.

Fig. 6402.



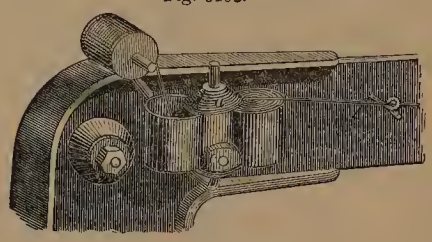
*Thread-Gage.*

**Thread-guide.** (*Sewing-machine.*) A loop, eye, or what not, to form a guide for the thread when it changes its direction at points between the spool and the needle eye.

**Thread-lace.** Lace of linen thread; such as Honiton, and many other kinds.

**Thread-oil'er.** To lubricate the thread and facilitate its passage through the goods or leather. It

Fig. 6403.



*Thread-Oiler.*

is placed upon the spool-wire of the machine, and secured by tightening the set-screw *c* in the oiler, which has a wire attached to support the screw, as shown in the cut. The button *a* has a notch at its lower end, by which the thread is conducted through the cup.

**Thread-pol'ish-ing Ma-chine'.** A machine for imparting the final gloss to thread preparatory to spooling. This is usually effected by passing it between rubbers or rollers.

In Fig. 6404, the thread is conducted from the bobbins *f* over pins *g*, and thence through size-bowls *a* and eyes to the rubber carriages $a'$ $a'$ $a'$ $a'$; these have each a series of projecting pins, between which the thread passes, and are connected with blocks $u'$ *z* caused to reciprocate in vertical guides *w* by cranks on the shaft *b* of the roller which rotates the bobbins. The upper and lower carriages simultaneously move in opposite directions toward and from the center *c*, and each pair may be disconnected without interference with others in case of breakage of the thread, which is wound upon the reels *l l*.

In the machine (Fig. 6405), the thread, after passing between a pair of sizing-rollers *G H*, is conducted through a guide *d* to a pair of rotary disks connected by a series of parallel bars *F*, which exert a rubbing action; thence through a second guide *e* to another pair of rotary disks connected by similar rubbing-bars, and finally, after passing through a pair of pressing-rollers *I I*, is wound upon reels. *J* is a brush for removing size from the bars *F*. Rollers or rotary brushes may be substituted for these bars. See also THREAD-FRAME.

**Thread-wax'er.** A bowl of heated shoemaker's wax, through which the thread is conducted in sewing-machines for boots, shoes, and leather.

In the example (Fig. 6406), the thread enters the side of the semicircular trough through the tension-aperture under the depressor, thence passes over the shaft and between the two elastic expressor-disks. The trough is heated by a lamp beneath.

See list under SEWING-MACHINE, Class C, section 2, pages 2108, 2109.

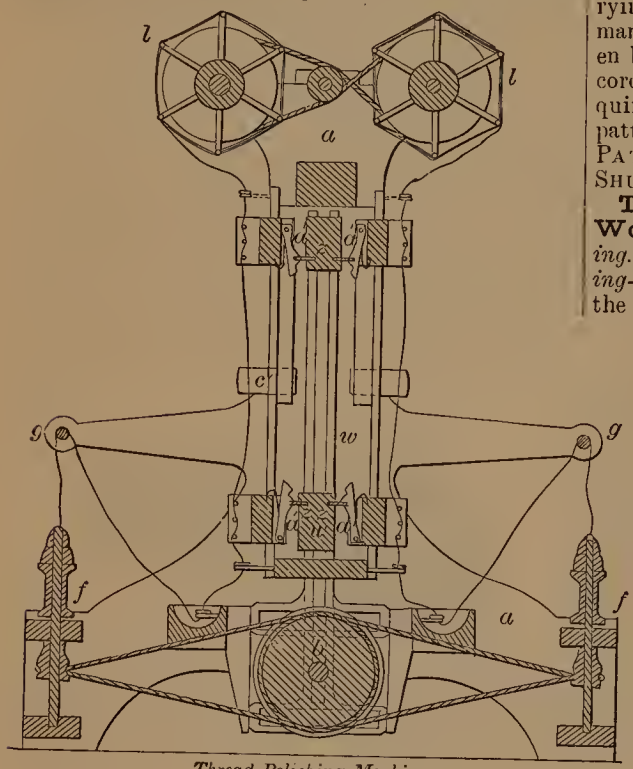
**Thread-wind'er.** A machine for spooling thread, etc.

In that shown (Fig. 6407), a friction-wheel *C* imparts motion to a small wheel on the axis carrying the spool. The

thread-guide *F L* has an adjustable pivot, by which it is adapted to different sizes of spools and thread, and is traversed, to lay the thread evenly on the spool, by a cam-wheel *R* rotated by a screw-thread on the shaft *B*.

Fig. 6408 is a machine for laying the exterior layers of button-hole twist, etc., on the spool, so as to form various patterns. The spool is placed on a spindle upon the pulley *M*, and part of

Fig. 6404.

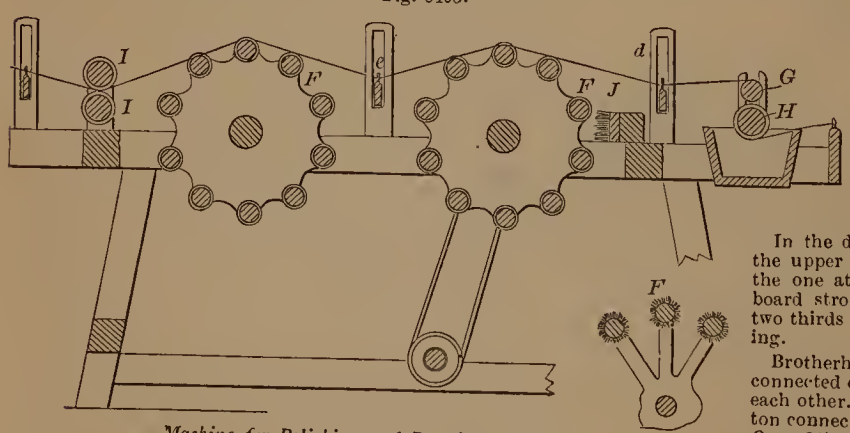



*Thread-Polishing Machine.*

the thread unwound and passed through the eye of the flyer *F* and the axis of the flyer and its pulley. It is then rewound upon the spool, the pattern formed upon the surface depending upon the angular adjustment of the arm carrying the pulley *M* and the velocity given to the pulley and flyer.

Fig. 6409 is a machine for winding thread for making fancy cassimeres. As the central thread or cord is spun or twisted and wound, the lapping thread of any other color is guided to it by slots in a tube through which the cord is conducted; a sectional pinion on the driving-shaft causes the delivery of the cord to be intermitted as desired, or the cord may be drawn

Fig. 6405.



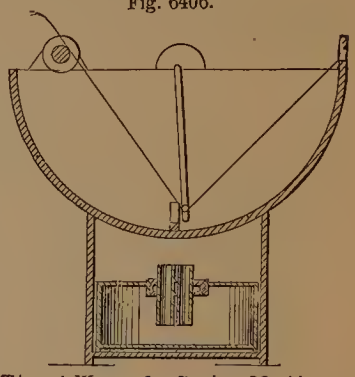

*Machine for Polishing and Dressing Thread.*

back a short distance from time to time, or the thread-guide may be reciprocated.

**Thread-wind'ing Guide.** A handle containing a holder for a spool, and having suitable tension-devices, and at one end an eye through which the thread is guided upon a bobbin.

**Three-box Loom.** (*Weaving.*) One having three shuttle-boxes, from which shuttles carrying yarns of as many colors are driven by the *picker*, according to the requirements of the pattern. See LOOM; PATTERN-CHAIN; SHUTTLE-BOX; etc.

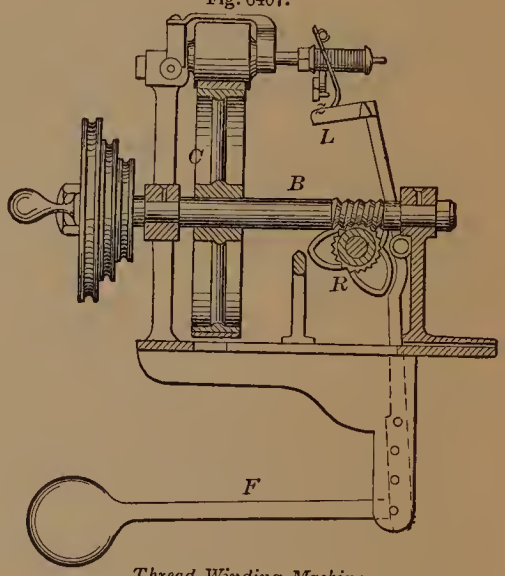
Fig. 6406.



*Thread-Waxer for Sewing-Machines.*

**Three-coat Work.** (*Plastering.*) The first is called *pricking-up* on lath; *roughing-in* on brick. The second coat is called *floating;* the third, *set* or *finishing-coat.*

Fig. 6407.




*Thread-Winding Machine.*

**Three-cyl'in-der En'gine.** An arrangement of three cylinders working on a common crank-shaft, to overcome the dead-center without a fly-wheel. The eccentrics and valves are so set that steam is admitted to the cylinders in succession, and not simultaneously, by which means the pistons are always in different thirds of their stroke, and two cylinders are always acting effectively.

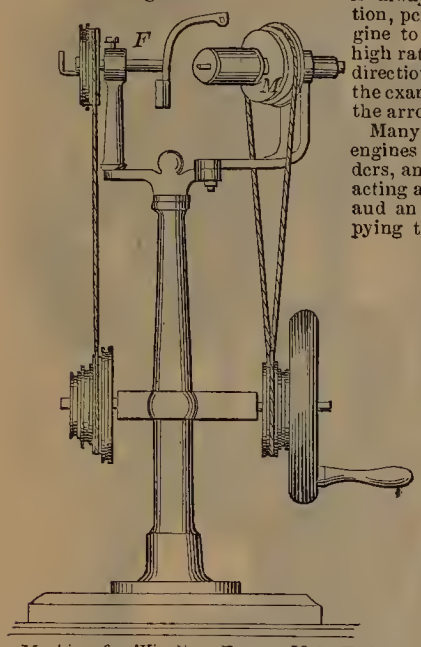
In the drawing (Fig 6412), the piston in the upper cylinder is at the outboard end, the one at the left at one third of the inboard stroke, and the one on the right at two thirds of the outboard end and exhausting.

Brotherhood's engine (Fig. 6413) has three connected cylinders *a b c* at angles of 120° to each other. Each has a deep but light piston connected to a crank *d*, common to all. One of the connecting-rods has a single eye at the crank end, while the other two are forked at that end, one straddling the other, so that their centers are in the same line. Steam is admitted into the central space *g* through the induction-opening *e*, and exhausted through the opening *f* in line with the crank-shaft. The supply and exhaust are effected by a revolving slide-valve carried around by the crank-shaft. The steam-pressure in the central chamber always exceeds that on the outer end of each

piston, but varies in amount, so that the strain on the connecting-rods and joints is always in one direction, permitting the engine to be run at very high rates of speed. The direction of motion in the example is shown by the arrow.

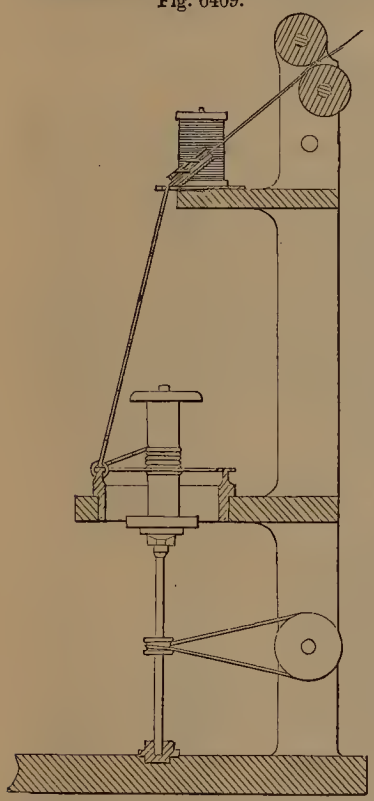
Many marine and river engines have three cylinders, and some have two acting at angles of 120°, and an air-pump occupying the position of a third steam-cylinder. A favorite arrangement with Maudslay and Penn.

Fig. 6408.




*Machine for Winding Button-Hole Twist.*

Fig. 6409.



*Machine for Producing Variegated Thread.*

The Baxter canal steam-engine has a pair of high-pressure cylinders and a lower-pressure cylinder between the other two.

In Willans's three-cylinder engine (Fig. 6414), each cylinder is single-acting, receiving its steam upon the upper side only of the piston. The connecting-rods attached directly to the pistons actuate a three-throw crank-shaft.

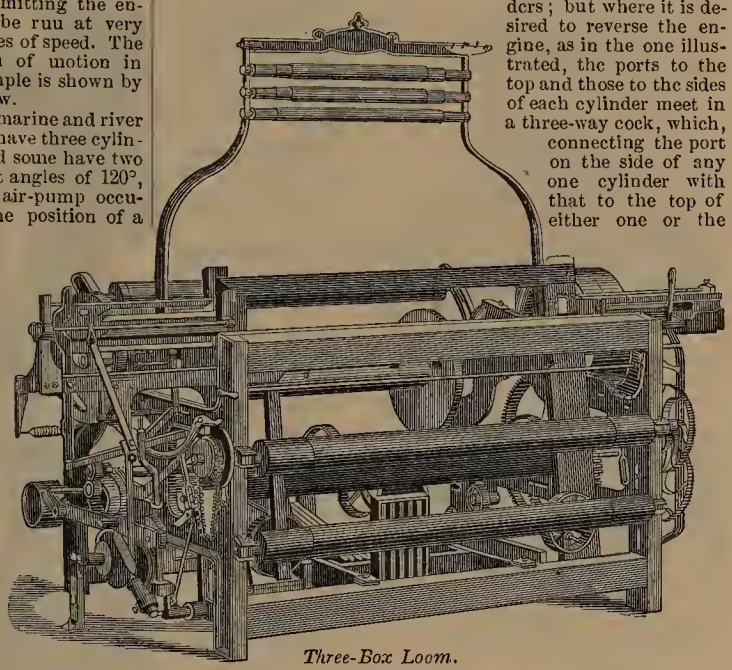
Each piston serves as a steam-valve controlling the supply of steam to one or the other of the two remaining cylinders. There is a steam-chamber in each piston and a port in its side. Steam is supplied by means of a hollow rod passing through the top of the cylinder into a steam-chest. When the piston attains three fourths of its downward stroke, its steam-port overlaps a port in the side of its cylinder, and steam then passes to the top of another of the cylinders. When the piston has reached about one half its return stroke, uncovering the port in the side of its cylinder, it allows the steam to escape from the cylinder into which it was previously admitted, into a casing round the crank-shaft, from which the exhaust-steam is taken either to a condenser or to the air, as the case may be.

In an engine which is required to run only one way round, the port in the side of each cylinder passes direct to the top of one of the other cylinders; but where it is desired to reverse the engine, as in the one illustrated, the ports to the top and those to the sides of each cylinder meet in a three-way cock, which, connecting the port on the side of any one cylinder with that to the top of either one or the other of the other cylinders, reverses the engine.

Fig. 6410.

*Thread-Winding Guide.*

Fig. 6411.



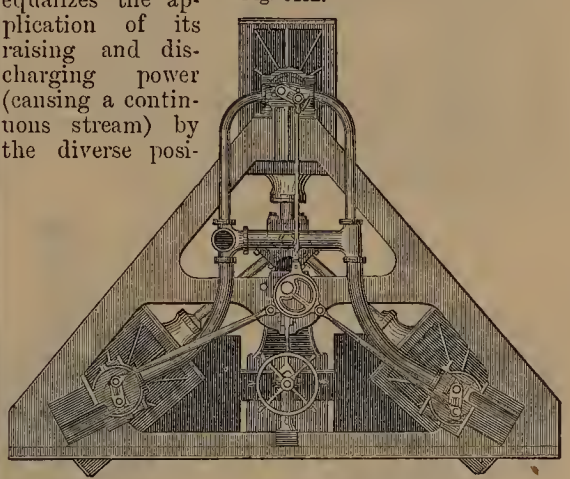
*Three-Box Loom.*

The equilibrium of the power is maintained by its threefold action.

The lubrication is done through a steam-lubricator on the steam-chest, and the waste oil passing down to the bottom of the casing lubricates the lower ends of the connecting-rods as they pass round.

**Three-cyl'in-der Pump.** Haskell's three-cylinder pump, having one inlet and outlet common to all the cylinders, equalizes the application of its raising and discharging power (causing a continuous stream) by the diverse position of the three-throw crank to which the pistons are attached.

Fig. 6412.



*Three-Cylinder Engine.*

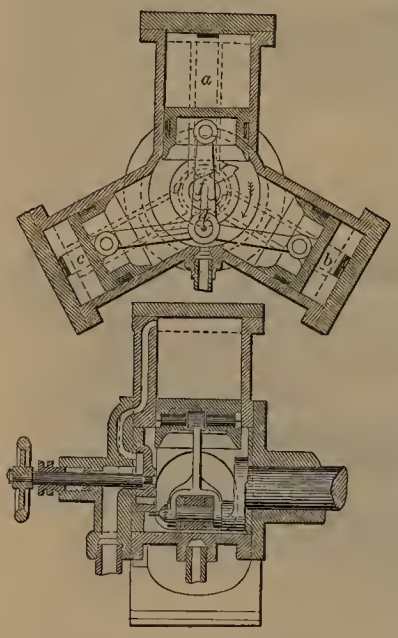
**Three-deck'er.** (*Nautical.*) A ship with three gun-decks.

**Three-head'ed Rail.** One having three treads united by webs, set at an angle of 120° with each other.

**Three-high Roll.** (*Metal-working.*) A rolling-apparatus in which three rollers are arranged in a vertical series, so that the metal may be passed through between the middle and lower roll, and then back between the middle and upper one; rolling it at each passage without changing the direction of motion of the rolls. See Fig. 4416, page 1969.

**Three-part Flask.** (*Founding.*) One containing a mold which comes off the pattern in three pieces. See *c d e*, Fig. 2010, page 877.

Fig. 6413.




*Brotherhood's Three-Cylinder Engine.*

**Three-pile.** (*Fabric.*) A costly thick pile velvet.

**Three-ply Car'pet.** A carpet made of wool, worsted, or a combination of the two, and having three webs whose warps are interchangeable, so as to allow such ones to be brought to the surface as may suit the development of the pattern. Also known as *triple-ingrain carpet.* See TWO-PLY CARPET.

**Three-square File.** The ordinary, tapering, hand-saw file of triangular cross section. *r*, Fig. 1965, page 840.

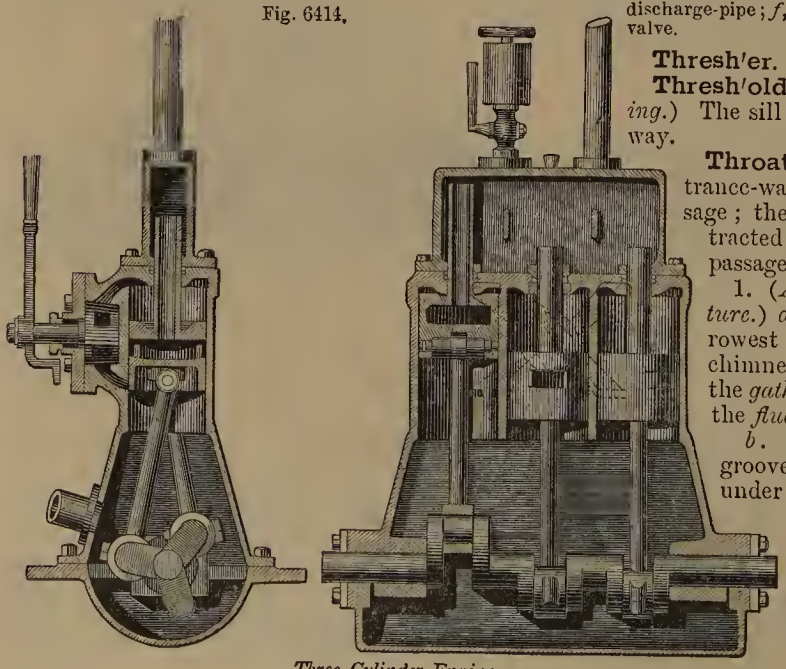
**Three-stone Mill.** A mill with one middle runner having two faces, which act against two lateral stones. See Fig. 2316, page 1021.

**Three-way Cock.** One having three positions, directing the fluid in either of three different channels.

In the illustration (Fig. 6417), the plug has a single transverse channel; when the direction of this is vertical, the flow is direct through the delivery-pipe, but when oblique or horizontal, the flow is into an auxiliary tube, which curves upward and then enters the delivery-pipe.

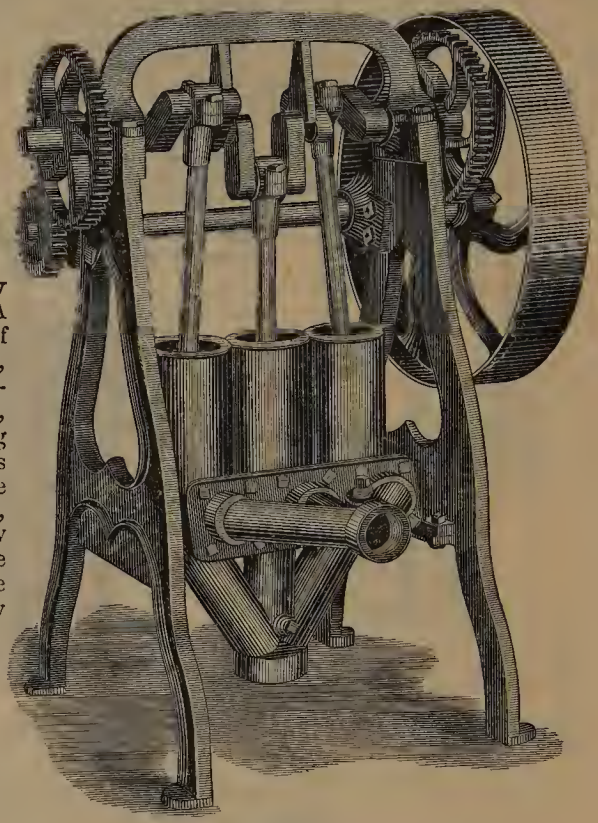
The *four-way cock* is an invention of James Watt. See Fig. 2091, page 912.

Fig. 6414.



*Three-Cylinder Engine.*

Fig. 6415.



*Haskell's Three-Cylinder Pump.*

**Three-way Valve.** One which governs three openings, as a THREE-WAY COCK (which see).

Fig. 6418 is a view of Locke's three-way balanced valve for hydraulic elevators. 1 shows it supplying water; 2, closed; 3, slowly discharging: corresponding to, 1, lifting the cage; 2, holding the cage stationary; 3, allowing the cage to descend gradually. The indented positions at the lower end of the valve and of the tubular downward prolongation into the square chamber are for the purpose of making the openings and closings gradually, so as to make the first flow of water gradual. *a* is the pipe from the main; *c*, pipe to the hoist; *l*, discharge-pipe; *f*, supply-valve; *s*, discharge-valve.

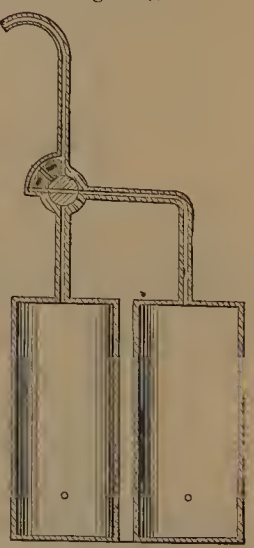
Fig. 6416.

*Three-Headed Rail.*

**Thresh'er.** See THRASHING-MACHINE.

**Thresh'old.** (*Building.*) The sill of a doorway.

Fig. 6417.



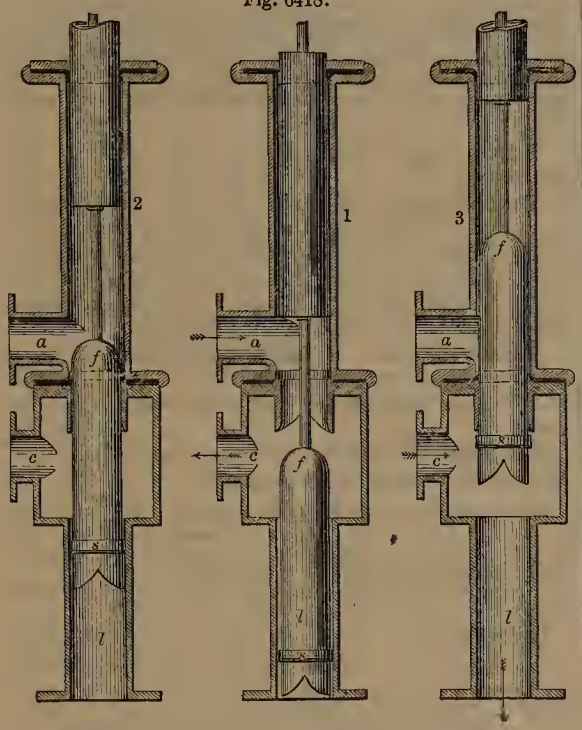
*Three-Way Cock.*

**Throat.** An entrance-way or passage; the more contracted part of a passage-way, as:

1. (*Architecture.*) *a.* The narrowest part of a chimney, between the *gathering* and the *flue.*

*b.* A small groove on the under side of a

Fig. 6418.




*Three-Way Balanced Valve for Hydraulic Hoists.*

coping or projecting molding. A *gorge*. See GUTTER.

2. (*Shipwrighting.*) The interior angle at the bend of the arms of a knee or compass timber.

3. (*Nautical.*) *a.* The crotch of a gaff where it rests against the mast.

*b.* The upper front corner of a fore-and-aft sail. The *nock.*

*c.* The interior angle at the junction of the arm and shank of an anchor.

4. (*Agricultural.*) The entrance-way where grain in the straw passes from the feed-board to the cylinder of a thrashing-machine.

5. (*Wheelwrighting.*) That portion of a spoke just beyond the swell at the junction of the hub, where the spoke is thinner toward its outer side.

6. (*Puddling.*) The narrowed entrance to the neck of the furnace, where the area of flue passage is regulated.

7. The opening in a plane stock through which the shavings pass upward.

8. (*Fortification.*) The narrowed space between the flanks of a bastion at their junction with the curtain, or between the rear ends of the faces of a *redan.* A gorge. See REDAN; BASTION.

**Throat-brails.** (*Nautical.*) Brails which lead through blocks beneath the jaws of a gaff.

**Throat-down'hauls.** (*Nautical.*) Ropes for rousing down the throat of a gaff.

**Throat-hal'yards.** (*Nautical.*) A tackle for lifting the gaff at the throat. The *peak* halyards lifts the other end.

**Throat-latch.** (*Saddlery.*) The strap which passes under a horse's throat and assists in holding the bridle in place. *Throat-band.*

**Throat-strap.** (*Saddlery.*) The upper strap of a halter that encircles the horse's throat; also called *jaw* strap.

**Throe.** A tool for splitting balks of timber into shingles or clapboards. A *frow.*

**Thros'tle.** 1. (*Cotton.*) The *drawing-frame* of the cotton manufacture. The great invention which succeeded the *spinning-jenny* of Hargreaves. The *drawing-frame* is for attenuating *slivers* of fiber by passing them through consecutive pairs of rollers, each pair in the succession revolving at a higher speed than its predecessor. Leon Paul, by patent of 1738, claimed a mode of spinning by rollers, but the device did not come into use. (See SPINNING.) Richard Arkwright perfected the invention and patented it in 1769.

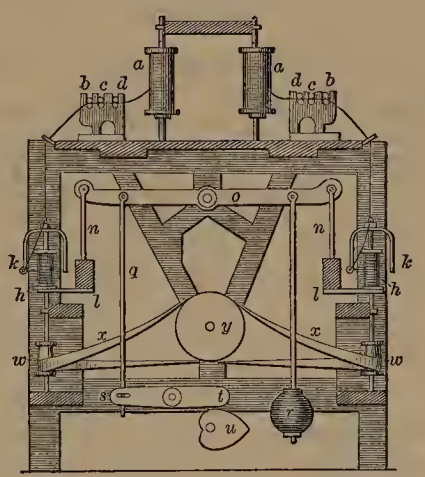
Arkwright's original spinning-frame was fed with rovings which passed between three pairs of rollers of successively increasing speed. The yarns were wound upon bobbins by means of flyers. It was the culmination of several attempts, and possesses the main features of the *throstle* and the *bobbin* and *fly-frame* in function, as well as in the relative positions of parts. See SPINNING, Fig. 5404, page 2271.

The *bobbin* and *fly-frame* is similar in principle to the throstle, and is adapted for giving a partial twist to the sliver as delivered from the carding-machine or the doubling-frame. The slivers in cans are fed to the *coarse* bobbin and fly-frame, where they are reduced and partially twisted so as to give them greater coherence, being elongated say 4½ times. The rovings thus produced are wound on bobbins which are placed on the *creel* of the *fine bobbin* and *fly-frame*, by which they are still farther reduced and twisted.

These rovings on their bobbins are then transferred to the throstle, a transverse vertical section of which is shown in Fig. 6419.

*a a* are two of the bobbins. The thread, as it is drawn off from these, passes through the drawing-rollers *b c d*, and then to the spindles. Here it is twisted and wound upon the bobbins. The bobbins *h* have no rotatory motion imparted to them,

Fig. 6419.




*Throstle.*

but simply rest upon the trays *l*, and are dragged round by the thread as it twists itself round them, as the fork or fly *k* revolves much more rapidly than the thread is given out from the drawing-rollers. The up-and-down motion of the bobbins is effected in the following manner: —

The lever *o* turns at its center on a spindle fixed to the framework. At its ends it is connected by the rods *n n* to the trays *l l*, upon which the bobbins rest, and receives an oscillating motion from the heart-shaped cam *u* through the lever *s t* and rod *q*. The cam depresses the one side of the lever, which is pulled down on the other side by the weight *r* as the cam recedes. By this means the trays, and therefore also the bobbins, are moved up and down. The spindles receive their motion from the drum *y* and the belts *x x* passing round the small pulleys *w w*. The speed of the rollers and spindles is proportioned to the required fineness of the yarn. For example, the drum *y* making 600 revolutions per minute, the spindles, whose pulleys are 1/6 of the diameter of the drum, make 3,600 revolutions. There are usually from 75 to 150 spindles on each side of the throstle, and they are set about 3 inches apart, all being driven from the drum *y*, which extends the whole length of the machine.

The specific difference between the action of the *throstle* and the *mule* is that the former has a continuous action, *drawing*, *twisting*, and *winding*; while the *mule* has an alternate action, *drawing* and *twisting*, and then *winding*.

It is thus stated by Tomlinson: —

"The *mule* having made a definite length of yarn, the operation of spinning is suspended while the yarn is being wound up

on bobbins or spindles. In the throstle the yarn is both spun and wound at the same time. The throstle-yarn is smooth and wiry, while the mule-yarn is soft and downy. *Throstle-yarn* is employed for warps of heavy goods, and for making sewing-thread; *mule*-yarn is used for the weft of heavy goods, and for the warp and weft of soft and fine goods." See BOBBIN and FLY-FRAME; DRAWING-FRAME; ROVING; MULE; DOUBLING; JENNY.

The throstle derived its name from the singing or humming which it occasioned. It was also called the *water-frame* from the fact that the machinery in Arkwright's mill, where it was first used, was driven by a water-wheel.

2. A spindle for wool.

**Throt'tle.** (*Steam.*) A name for the THROTTLE-VALVE (which see).

**Throt'tle-le'ver.** The handle of the throttle-valve.

**Throt'tle-valve.** (*Steam-engine.*) A valve which regulates the supply of steam to the cylinder. In the Watt engine it is a disk turning on an axis and occupying in its transverse position the bore of the main steam-pipe.

It is frequently an ordinary conical valve with a stem operated by a screw.

In land engines it is generally connected with the governor.

**Through-bolt.** (*Machinery.*) A bolt passing entirely through and fastened on opposite sides of the object or objects secured by it, as in 1, 3, 4, 5, Fig. 768.

**Through-bridge.** One in which the track rests on the lower stringer (Fig. 2702, page 1201) in contradistinction to a *deck*-bridge (*a*, Fig. 3775, page 172), in which the track occupies the upper stringer, the top of the truss.

**Through-stone.** A bond-stone, extending across the thickness of the wall. A *perbend.*

**Throw.** (*Machinery.*) The radial reach of a crank, eccentric, or cam.

**Throw-crook.** 1. (*Husbandry.*) A tool like a brace for twisting hay or straw bands. See Fig. 2448.

2. (*Pottery.*) A potter's wheel. A *thrower.* See THROWING-TABLE.

**Throw'ing.** 1. A third process in the spinning and combining of silk thread. See THROWN SINGLES.

2. (*Pottery.*) The operation of forming a mass of clay into a vessel on the potter's wheel.

**Throw'ing-en'gine.** (*Pottery.*) A potter's wheel. A revolving disk on which clay is formed by the hands of the potter, into the shape of a vessel.

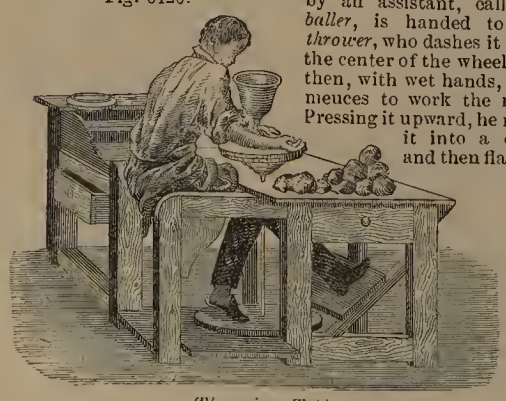
**Throw'ing-mill.** See THROWING-TABLE.

**Throw'ing-ta'ble.** A revolving, horizontal table on which earthen vessels are shaped by the potter.

Clay ware is *thrown*, *pressed*, or *cast*. In some cases, after being partially dried, it is *turned* to give it smoothness.

The throwing table consists of a horizontally rotating disk, turned by the foot, an assistant, or by machinery.

Fig. 6420.



*Throwing-Table.*

A lump of clay prepared by an assistant, called a *baller*, is handed to the *thrower*, who dashes it upon the center of the wheel, and then, with wet hands, commences to work the mass. Pressing it upward, he raises it into a cone, and then flattens it so as to express bubbles. Then, with skillful motions of the hand inside and out, aided by a piece of horn, bone, or porcelain, and called a *rib*, he gives it the shape shown in the figure. The outer surface is worked by a *templet*, and gages projecting horizontally from a post upon the table assist the eye of the workman in giving the required hight to the shoulder and the lip.

**Throw'ing-wheel.** A potter's wheel. See THROWING-TABLE.

**Throw-lathe.** A small lathe which is driven by one hand, while the tool is managed by the other.

**Thrown.** (*Mining.*) When a lode is intersected by a slide, if the undiscovered portion of the lode has apparently been lengthened, it is said to be *thrown up*; if the reverse, it is *thrown down.*

**Thrown Silk.** A silk thread made of two or more *singles*, twisted together in a direction contrary to the twist of the *singles* of which it is composed.

**Thrown Sin'gles.** Silk thread, the result of three separate spinning operations.

Silk filaments are twisted to form *singles.* Several of these are combined and twisted together (doubling), forming *dumb singles.* A number of the latter are associated and twisted together (*throwing*), forming *thrown singles.*

This, if single-twisted, is *tram*; if double-twisted, is *organzine.*

If the gum be left in it, it is *hard silk*; if the gum be removed, *soft silk.*

The operation is as follows: the filaments of silk from the bobbin are twisted in one direction, and the *single* thus obtained is wound on a second bobbin. A number of bobbins containing singles are placed in a frame, and their ends, being united, the combined bunch of singles is wound on a bobbin, and from thence on to a reel. From this the bunch of singles is conducted to a rotating flyer, which twists it and delivers it as *thrown* silk on to a bobbin. See DOUBLING.

**Thrum.** 1. (*Nautical.*) *a.* Coarse untwisted rope, used for mops and for mat-making.

*b.* A wad of such yarns or a sail passed overboard and hauled into the vicinity of a leak, so as to be drawn thereinto.

*c.* To insert tufts of hemp or coir in the meshes in making a rope-mat.

2. (*Weaving.*) The ends of the warp or weft threads.

**Thrust.** 1. (*Mining Engineering.*) The breaking downward of the roof of a gallery, owing to the weight of the superincumbent strata. Opposed to *creep*, which is an upheaval of the gallery floor.

2. (*Husbandry.*) The white whey which last leaves the curd in pressing.

**Thrust'ing-screw.** The screw of a screw-press; of a cheese-press, for instance.

**Thumb-cleat.** (*Nautical.*) A small cleat forming a leader to carry the bight of a rope.

Fig. 6421.

*Thumb-Nut.*

**Thumb-nut.** One having wings by which it is turned by the thumb and finger to tighten upon its bolt.

**Thumb-screw.** 1. A screw with a flat-sided head, adapted to be turned by the finger and thumb.

2. An old instrument of torture to break the thumb-joint. A *thumb-kin.*

**Thumb-stall.** 1. (*Ordnance.*) A stall of buckskin stuffed with hair, which a cannoneer wears on his thumb to cover the vent while the piece is being sponged and loaded.

2. A sailor's thimble used in sail-making.

**Thun'der-rod.** An old-time name for the lightning-rod, designed to make their houses

"Secure of thunder's crack." — TITUS ANDRONICUS.

**Thurl.** (*Mining.*) *a.* A short communication between *adits.*

*b.* A long adit in a coal-pit.

*c.* To make a breach into former workings or gate-roads.

**Thurst.** (*Mining.*) The ruins of the incumbent strata after the *pillars* and *stalls* are wrought out.

**Thwack'ing-frame.** (*Tile-making.*) A table with a curved top, upon which a half-dried pantile is bent to form. The tool by which the upper side is beaten has the shape of the segment of a cylinder, and is called the *thwacker*.

**Thwart.** (*Nautical.*) One of the transverse planks which keep the sides of a boat asunder, like the beams of a ship, and serve as seats for the rowers. They are spaced about 2 feet 10 inches apart, from center to center, in single-banked boats, and 3 feet in double-banked boats.

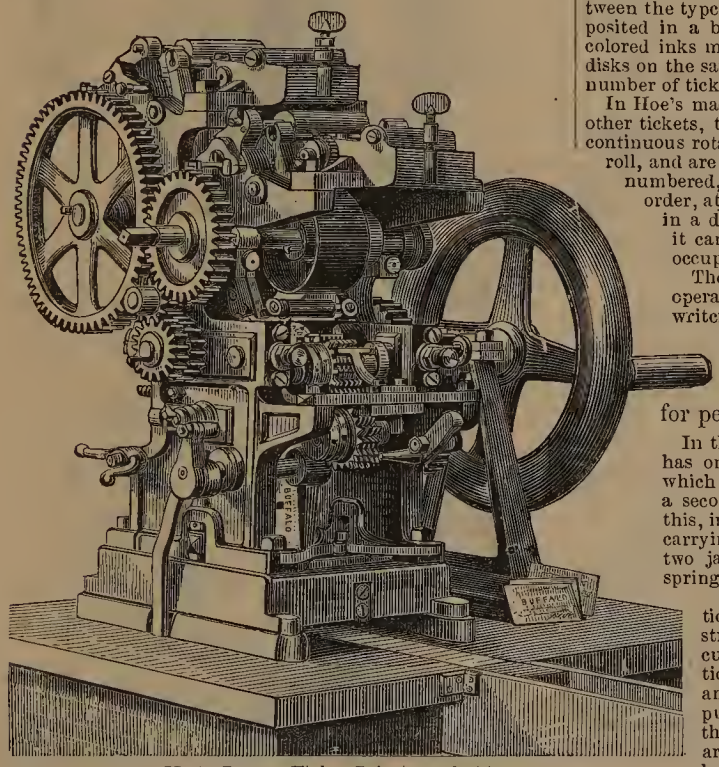
**Tib'i-a.** (*Music.*) Formerly, a flute; as made of the leg bone of an animal.

**Tick.** (*Fabric.*) A woven fabric for holding the filling of mattresses and beds. *Ticking; ticken.*

**Tick'et.** A piece of card, bone, ivory, metal, or what not, printed, impressed, or plain, the equivalent of a sum of money paid for a ride, admission to a concert or other entertainment, etc. One meaning of the Latin *tesseræ*.

Pericles founded the practice of paying for places at theaters; and at Pompeii have been found bone tickets of admission, one side representing the theater, and the reverse having words and figures, some with the place in the theater to which they gave admission engraved upon them. See farther in Fosbroke's "Ency. Antiq.," I. 386, 387.

Fig. 6422.



*Hoe's Rotary Ticket-Printing Machine.*

**Tick'et-hold'er.** 1. A device to hold a railway ticket in the hat or to the lappel of the coat; or a tag to a bale or package. See TAG.

2. A contrivance to attach a card or check to a trunk or parcel. See BAGGAGE-CHECK, Fig. 524, page 210.

**Tick'et Print'ing and Num'ber-ing Machine'.** A machine for printing and consecutively numbering tickets. The first machine of this kind was invented by Edmondson, in England, about 1840, and was designed to remedy the troublesome practice then in use on railways of stamping and tearing each ticket from a book previous to its delivery to the purchaser. This machine imprinted the date and consecutively numbered the tickets, but was imperfect in its inking arrangements, frequently rendering the tickets illegible.

Church and Goddard's machine, introduced subsequently, printed, numbered, cut, counted, and packed the tickets. Pasteboard, cut into strips, is placed in a feed-trough and brought under the prongs of a fork working with an intermittent movement, and passes successively between four pairs of horizontal carrying-rollers, by which it is intermittingly moved forward over a bed carrying the type and the numbering-rollers. At each stop, during the forward progress of the strip, the bed is caused to rise by means of a cam-movement, and print first the denomination of the ticket, and secondly the number; as it falls after each upward movement a self-acting apparatus inks the type. The completed ticket is then severed between a fixed knife and a reciprocating knife attached to the bed, and is delivered into a box provided with a piston by which the tickets are packed.

A counting-apparatus connected with the working parts of the machine is caused to ring a bell when a certain number of tickets (say 100) is completed. The numbering disks are operated in a manner analogous to those employed for paging books.

In another machine the types and numbering-disks are fixed in a metallic frame, which also carries the numbering-disks. The frame is mounted on a rock-shaft, and is rocked by means of a handle to bring the types down on the card and produce an impression; as it is raised again, the unit disk is advanced one figure, and the types are inked by a roller receiving its supply from an inking-table which forms the top of the frame.

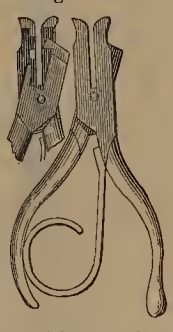
Baranowski's machine (French) has a horizontal shaft, having near each end a disk, carrying a metallic frame of similar curvature to the disk, and on which the type and numbering-disks are arranged radially to the shaft. The type-frame has a slot or opening through which the peripheries of three numbering-disks project. The tickets are automatically fed one by one between the type-frame and a press-roller of india-rubber and deposited in a box. The arrangements are such that different colored inks may be used upon the same ticket. Registering-disks on the same shaft with the numbering-disks indicate the number of tickets printed.

In Hoe's machine for printing and numbering railway and other tickets, the forms are placed on a cylinder which has a continuous rotary movement. The tickets are worked from a roll, and are printed at the rate of 10,000 to 12,000 an hour, numbered, cut, and deposited in a receptacle in regular order, at a single operation. The number may be printed in a different color from the body of the ticket, and it can be changed with great facility. The machine occupies a space of about two feet square.

The Rand and Avery machine is very rapid. It is operated with closed doors, and though shown to the writer, it may not be their wish to have a description published.

**Tick'et-punch.** A punch used by railway and street car conductors for perforating tickets.

Fig. 6423.



*Ticket-Punch.*

In the example, the fixed jaw has one longitudinal slot, into which the ticket is inserted, and a second slot at right angles to this, in which the movable jaw carrying the punch works. The two jaws are kept apart by a spring when not in use.

The alarm and registering ticket-punch, now used on street-cars and elsewhere, cuts off and saves a piece of a ticket or a trip slip, and gives an audible notice of the punching. The pieces and the register (if there be one) are the records of the number of passengers, and the bell-alarm calls the attention of the payer to the fact of the punching, enlisting his attention in the service of the company.

See also patents

| | | | |
|---|---|---|---|
| No. 65,090 | No. 79,470 | No. 89,823 | No. 111,391 |
| 68,687 | 79,498 | 100,036 | 115,119 |
| 69,019 | 84,739 | 101,598 | 135,549 |
| 79,232 | 86,438 | 111,345 | |

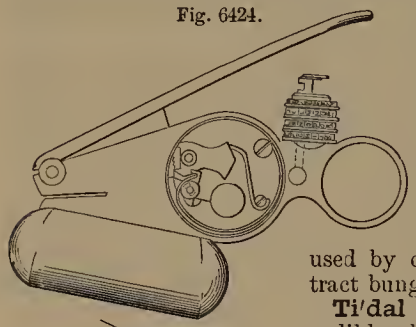
**Tick'ing.** (*Fabric.*) A closely woven, striped linen or cotton cloth to hold feathers, husks, or other filling for beds or mattresses. It is usually twilled.

**Tick'len-burgh.** (*Fabric.*) A coarse, mixed linen fabric.

**Tick'ler.** 1. A book or case containing memoranda.

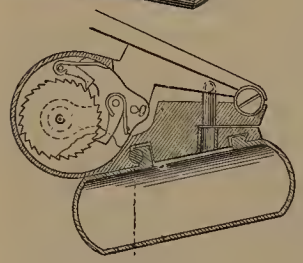
The memorandum-book of the Middle Ages was the volume which was most read by the owner. Petrarch had a MS. Virgil, with the commentary of Servius. It contains marginal notes in his own hand, and an account of the death of Laura, on a distinct leaf of paper pasted on the wood of the binding.

Fig. 6424.



2. A prong used by coopers to extract bungs from casks.

**Ti'dal A-larm'.** An audible alarm operated by the ebb and flow of the tide.



*Alarm and Registering Ticket-Punch.*

It is placed on a spit or shoal to warn off vessels during fogs, being on a vessel or buoy moored to the spot, or on a post or pile driven into the sand or shingle. It may be a bell, whistle, or trumpet, rung or blown by the impact of the passing tidal current. See FOG-ALARM.

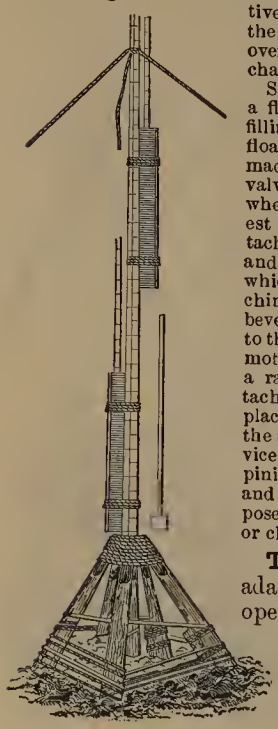
**Ti'dal Ba'sin.** A dock filled at high tide.

**Ti'dal Mo'tor.** An arrangement by which the ebb and flow of the tide is utilized as a source of power to move machinery, etc. The idea is not new, and various devices have been invented for accomplishing the object.

A common mode is to place gates at the mouths of inlets which are opened during the flood and closed at the commencement of ebb tide; the head of water thus obtained is used to turn a mill-wheel. Signor Thomassi has proposed to use the rise of the tide as a means of compressing air in a chamber or reservoir, from which the air thus compressed may be conducted to any number of stationary engines, the effective power thus obtained being proportional to the excess of its tension over that of the atmospheric pressure; this may be greater or less in proportion to the relative contents of the chamber into which the water is admitted, and that in which the air is condensed.

By an additional chamber, in which a partial vacuum is produced by the reflux of the tide, a continuous motor is produced, the effective force in this case being equal to the excess of atmospheric pressure over that of the rarefied air in the chamber. See also SLUICE.

Fig. 6425.



*Tide-Gage.*

Scharit's tidal motor consists of a float, with a screw and valves for filling the float with water. The float cousists of a rectangular box made water-tight, and provided with valves for the admission of water when the float has reached its highest point. To the float a nut is attached, which works upon the screw and imparts thereto a rotary motion, which is communicated to the machinery to be driven by means of bevel-gears, one of which is attached to the top of the screw. A continuous motion in one direction is secured by a ratchet and pawl, which are attached to the horizontal shaft that is placed directly over the center of the screw. Modifications of this device have double racks working in pinions for communicating power, and a single rack for the same purpose; another modification has ropes or chains working on pulleys.

**Ti'dal Valve.** A valve adapted to sluice-ways, which opens to the pressure of the land water when the tide falls, and closes as the tide rises, to prevent the flooding of the land by sea-water. See SLUICE.

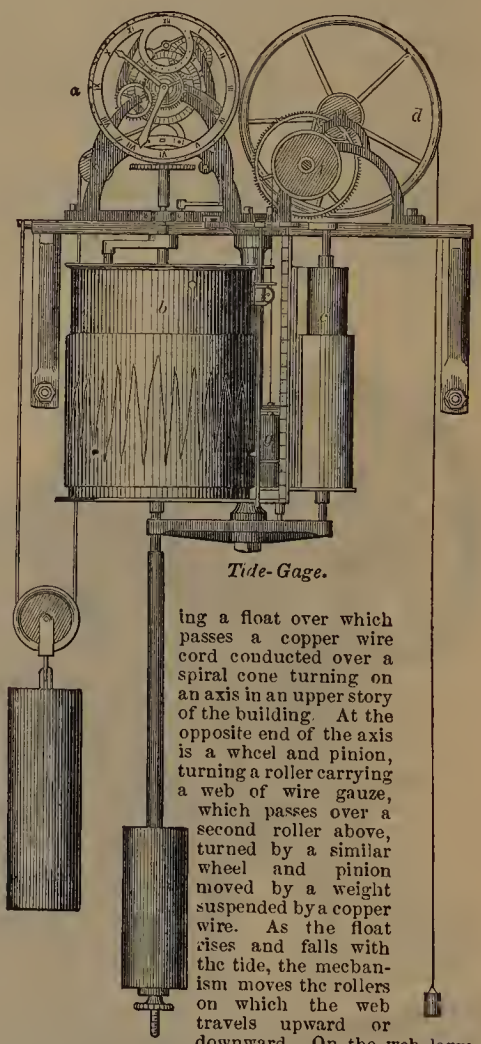
**Tide-di'al.** See TIDE-GAGE.

**Tide-gage.** Used in harbors to measure the rise and fall of the tides. A common form consists of a graduated spar, 24 feet long, and having boxes at the side, in which is a float with an elevated stem. The spar is secured to a pier or quay, or is anchored in a frame and secured by guys. The rod is $\frac{3}{4}$ inch in diameter, and is supported by a cork of 3 inches cube. The stem is guided by staples in the spar.

The tide-gage at Sunderland, England, invented by Mr. Meik, engineer of that harbor, is self-registering, and shows to mariners the depth of water on the bar at all stages of the water.

A well is sunk beneath the building containing the apparatus, its bottom being on a level with that of the entrance to the channel. This contains a pipe, open to the water, and containing a float over which passes a copper wire cord conducted over a spiral cone turning on an axis in an upper story of the building. At the opposite end of the axis is a wheel and pinion, turning a roller carrying a web of wire gauze, which passes over a second roller above, turned by a similar wheel and pinion moved by a weight suspended by a copper wire. As the float rises and falls with the tide, the mechanism moves the rollers on which the web travels upward or downward. On the web large figures are painted in a white, transparent varnish on a dark ground, and as it moves up and down, two fixed pointers indicate in feet and half-feet the depth of water on the bar at that time. The figures are visible to a considerable distance at sea, and are strongly illuminated at night.

Fig. 6426.




*Tide-Gage.*

The self-registering gage is also actuated by a float in a well, which, by means of a cord passing over a wheel, moves a rack carrying a pencil, which traces on a ruled web of paper passing over a drum turned by clock-work a line corresponding to the fluctuations in the hight of the water. The web of paper is of sufficient length to receive the automatic record for fourteen days.

Fig. 6426 illustrates Sir William Thomson's self-registering tide-gage. It consists of a clock *a* supported on a stand, and which, besides keeping time, actuates the drum *b* which winds upon itself with a uniform movement a continuous web of paper from the cylinder *c*. A cord or fine wire passing over the pulley *d* carries at one end a counterbalanced float-weight *e* which rises and falls with the tide. A pinion on the end of the shaft of the pulley *d* engages a gear-wheel on the shaft of the pulley *f*, from which is suspended a weighted ink-bottle *g* carrying a

pen. These rise and fall with the movement of the float *f*, though their motion is less in the proportion of the respective diameters of the wheel and pinion. The pen traces a continuous record on the paper in the form of a zigzag line, the angles of which correspond with the hights of high and low water, the horizontal distance between each two angles answering to the intervals of time between two high or low tides.

**Tide-gate.** The lock-gate of a tidal basin. See SLUICE.

**Tide-lock.** One situate between the tide-water of a harbor or river and an inclosed basin when their levels vary. It has two pairs of gates. A *guard-lock*.

**Tide-me'ter.** See TIDE-GAGE.

**Tide-mill.** A mill driven by a wheel set in motion by the tide.

Mills of this kind were used in Venice as early as 1078, and they were employed in London in 1772.

Generally the water is admitted as the tide rises, through a sluice over which the mill is placed, into a reservoir, turning the wheel in its passage through the sluice. At high tide the sluice-gates are shut until the tide has fallen sufficiently, when they are again opened, and the water again turns the wheel during its outward passage.

The mill may float on the surface of the water, rising and falling with the tide. The flood-gate in this case is arranged to have a simultaneous and equal rise and fall, so as to maintain a uniform head of water.

Dr. Gregory enumerates four different arrangements of tide-mills: —

1. The water-wheel may turn one way when the tide flows, and the other way when it ebbs.
2. The wheel may turn in a constant direction, in either course of the tide.
3. The water-wheel may rise and fall, as the tide ebbs and flows.
4. The axle of the wheel may be fixed, the wheel receiving the influx and efflux of the water, being more or less submerged according to the state of the tide. The former is the preferable arrangement. See also TIDE-WHEEL.

**Tide-wheel.** A wheel turned by the ebb and flow of the tide, and employed as a motor for driving machinery, etc.

The most remarkable variations in the tide are at Chepstow, where the rise of spring tides is about 60 feet; at Bristol it is 40 feet; in Mount St. Michael's Bay it is 46 feet; in the Bay of Fundy and on the coast of Nova Scotia it is about 60 feet; whilst in the Northern Atlantic it is on the average from 10 to 12 feet; at St. Helena only 3 feet; and on the shores of the islands of the Pacific it is barely perceptible.

Where the rise is so extreme, it is produced by the contraction of the sides of the river or estuary, as the Bristol Channel, for instance, or a convergence to one point of wide stretches of coast, as at the Bay of Fundy.

In some cases the phenomenon of the *bore* is produced, which is defined by Colonel Emery as being a peculiar undulation, which announces the arrival of the flood tide in many rivers. It consists of two, three, or sometimes four waves, very short, and succeeding one another rapidly, which bar the whole river, and ascend it to a great distance; they often break upon the crown, and upset everything they meet in their course, and are accompanied by a fearful noise. In the Severn, the bore is stated to be of almost daily occurrence, and sometimes even to attain a hight of 9 feet; in the Dordogne it rises from 5 to 6 feet, and travels at the rate of about 5 miles in 34 minutes; in the Seine it does not exceed 3 feet; in the Thames it only exists in a rudimentary state; whilst in the Hoogly, at Calcutta, it rises about 5 feet, and is transmitted at the rate of about 17½ miles per hour; and in the Menga the rise is said to be 12 feet.

The tide-wheel at East Greenwich on the Thames is, or was, a breast-wheel raised and lowered with the tide, so as to always have a submergence of four feet water. The buckets are divided into four steps, so as to prevent any jerking or irregular motion. The wheel turns both with the flowing and ebbing of the tide, having a sluice-gate and tail-gate on each side, one pair being opened when the other pair is closed.

Dryden's is an undershot-wheel, each float being set at an equal angle with the radius drawn from it to the center. The bottoms of the buckets have narrow openings to admit air as they rise from the water, so that they may not have to overcome atmospheric pressure.

A species of wheel like the sails of a windmill may be employed, having a vane or float so arranged that it will always turn the same face toward the current, and its axis always rotate in the same direction. See CURRENT-WHEEL.

The turbine is also employed, but is adapted to work with one flow only.

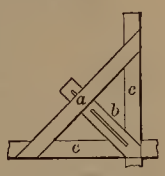
Gwynne's double-acting balanced pressure-wheel is intended to produce a continuous movement both with the ebb and flow; the buckets are arranged to present a direct surface to the passage of the water in either direction, and the wheel turns on a vertical spindle in a casing through which the water flows

**Tie.** 1. (*Architecture.*) A beam or rod which secures parts together and is subjected to a tensile strain; as a *tie-beam*, which forms the base of the triangle in a roof-truss and withstands the outward thrust of the rafters. See ROOF; TRUSS; KING-POST; QUEEN-POST; TIE-BEAM; RAFTER; etc.

It is the opposite of a *strut* or *straining-piece*, which acts to keep objects apart, and is subject to a compressing force; such as a COLLAR-BEAM, or STRAINING-BEAM (which see).

An angle tie or brace is a framing on the inner side of an angle, for the purpose of tying the work together. Fig. 6427 represents the framing of the external angle of a building.

Fig. 6427.




*Angle-Tie.*

*a*, angle or diagonal tie.
*b*, dragon-piece.
*c c*, wall-plates.

2. (*Railway Engineering.*) A piece of timber laid transversely of the track and held down by *ballasting*, serving to retain in place the rails, which are spiked to it.

3. (*Nautical.*) *a.* A mooring-bridle.

*b.* A *lashing*.

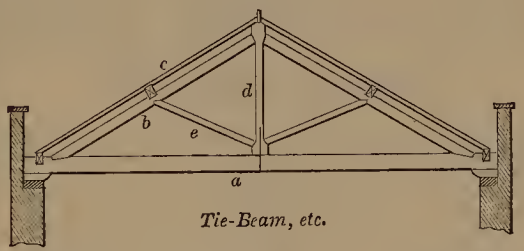
4. A band-fastening for bale-straps. See BALE-TIE, Fig. 540, page 218.

5. (*Mining.*) A support for the roof, attached to a rib.

**Tie-beam.** (*Carpentry.*) A horizontal timber in a frame connecting posts, and secured to them by a joint, or by mortise, tenon, and pin.

In a roof-truss the king or queen posts are planted upon it, and are strapped thereto. The feet of the *principal rafters* are stepped into the tie-beam which withstands the outward thrust. In dwellings the tie-beams support the ceiling of the room below.

Fig. 6428.




*Tie-Beam, etc.*

*a*, tie-beam. *b*, principal rafter. *c*, common rafter.
*d*, king-post. *e*, strut.

**Tier.** 1. (*Nautical.*) *a.* A range of *fakes* of a cable or hawser. A *fake* is a single coil in a tier.

*b. Cable tier.* A place below decks where the cable is coiled.

*c.* A row or rank, as of vessels alongside a wharf, or moored alongside each other in a stream.

2. (*Music.*) A row of pipes in an organ.

**Tie-rod.** A rod acting as a tie in a truss or other structure.

**Tier-saw.** One for cutting curved faces to bricks for arches and round pillars.

**Tier-shot.** Grape-shot in regular tiers divided by disks.

**Tie-strap.** (*Saddlery.*) A long strap having a buckle and chape on one end, used as an extra strap to a bridle for tying.

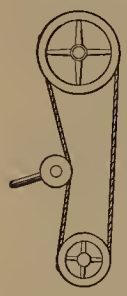
**Tie-wall.** A transverse wall in the hollow spandril of an arch, at right angles to the spandril wall.

**Tiffa-ny.** A thin silk gauze.

**Tige.** (Fr. *tige.*) A stem or stalk. A pin at the base of the breech in the Thouvenin system of fire-arms, for expanding the base of the ball; an anvil or support for the cap or primer in a central-fire cartridge.

**Ti'ger.** (*Sugar.*) A tank having a perforated bottom, through which the molasses escapes.

Fig. 6429.



*Tightening-Pulley.*

**Tight'en-ing-pul'ley.** One which rests against the band in order to tighten it, to increase its frictional adhesion to the pulleys over which it runs.

**Til'bur-y.** An open carriage on two wheels. A form of *gig*.

**Tile.** 1. A thin slab of baked clay.

It was used in great quantity in ancient Mesopotamia among that wonderful people that has passed utterly away, leaving mural remains indicating that it was the most densely populated region of antiquity.

In that country the common mode of keeping records of national and historical events was by stamping inscriptions upon tiles of clay, which were baked after the impression was made Mr. Layard, in the course of his excavations at Nineveh, found a large number of these records, some of which were written with such minute characters that a microscope was required to decipher them. He believed that they were read by a magnifying lens, one of which, made of rock crystal, he found among the ruins of the palace of Nimroud.

These tiles are stored away in such order that they were evidently records, but a commoner description of tile furnished the material for many of their structures, sometimes in conjunction or alternation with brick, from which it differed more in form and proportions than in any essential respect.

The tiles of Assyria and China lead the way, so far as the history of this art is concerned, for the Egyptian system was not favorable to the existence of tiles, even in rainless Upper Egypt. While the bricks of Babylon were some burnt and some adobes, the bricks of Egypt were universally adobes, or merely sun-dried, and this does not suit a thin tile, however well it may answer for a thick brick. The references to tiles in Holy Writ are not infrequent. We read of tiles in Ezekiel and in the Gospel of Luke, where the sick man was let down through the tiles. Tiles were also common in Rome at that day.

The art of glazing tiles came from China, and before the introduction westward of this Chinese art, neither bricks, tiles, nor earthenware was glazed, but in cases where it was necessary to render their earthen vessels water-proof, they were daubed with pitch, wax, tallow, or other resistant. See POTTERY.

The vitreous glazes passed from China to India, and spread from thence after the conquest of the latter country by Mahmoud of Ghuzna, the bogy of the warrior episode, in Moore's "Paradise and the Peri." His conquest, wherein, as Moore says, he

> "Choked up with the glittering wrecks
> Of golden shrines the sacred waters,"

occurred A. D. 1000, about the time that Gerbert of Auvergne, the schoolmaster of Rheims, was introducing the civilization of the Spanish Saracens into France and Italy.

The passion for glazed tiles extended from India and Ispahan to Spain, from the thirteenth to the sixteenth centuries.

The palace of the Alhambra at Granada, the residence of the Moorish kings, was built in 1280, and many of the rooms are ornamented with glazed tiles.

The tomb of Sultan Mohammed Khoda-Bendeh, at Sultanich in Persia, was also built in the thirteenth century, and is ornamented on the cupola and minarets with a green glazed tile, and on the architrave with a dark blue tile.

The painted mosque of Gour, in India, now in ruins, was built in 1475, and derives its name from the profusion of glazed tiles which adorned it.

In Ispahan, the domes and mosques are covered with green and blue tiles; and the caravanserai at Mayar, near Ispahan, built in 1580 by the mother of Shah Abbas, is inlaid with green tiles.

The art of glaziug tiles passed from Spain to Italy, which soon became celebrated for the taste and execution of its works in that line. Raffaello himself made designs for the paintings in *terra invitriata*.

The art spread to Holland, and long abode there. Delft was its headquarters; and the Dutch tiles, which some of us can recollect as lining the capacious fireplaces of old mansions, have been studied by many thousands besides the excellent Doddridge, who there learned Scripture history.

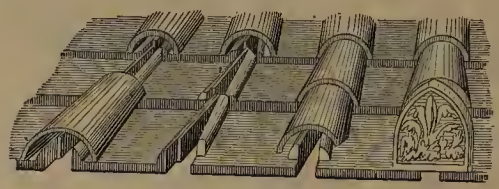
The glaziug of delft-ware is given under POTTERY (which see). Under the same caption will also be found a description of the mode of making porcelain, which is closely allied to our present subject.

Rome was originally roofed with shingles; tiles of baked clay were introduced about the time of the war with Pyrrhus.

Tiles of marble were used in Greece about the time of Pausanias, 620 B. C. The temples of Jupiter at Olympias, of Athenæ at Athens (the Parthenon), were thus covered.

Tiles of bronze, gilt, were also used in some cases. The lower edges of the joint tiles were protected and ornamented by *frontons*. The edges of the flat tiles were turned up and covered by semi-cylindrical joint tiles, termed *imbrices*.

Fig. 6430.

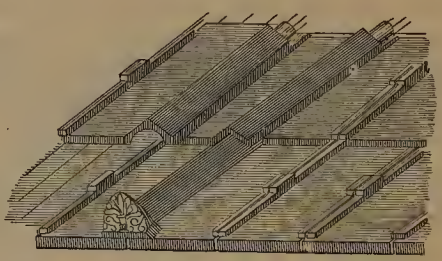


*Roman Tiles.*

The Greek and Roman tiles were made of marble, and have been imitated in clay.

Flat tiles with raised edges extend from rafter to rafter, the upper end having a rib that enters a groove formed on the under side of the tile placed above it. After these are laid, the joints above the rafters are covered with other tiles, each formed like the half of the frustum of a hollow cone, so that they are able to lap upon each other, their edges lying snugly to flat tiles of the roof. The end of these ridge-tiles was terminated by an ornament.

Fig. 6431.



*Greek Tiles.*

Tiles, both flat and curved, were in great demand in Roman architecture. Roofs were covered with the flat and curved tiles alternating. Tiles two feet square with a foot at each angle were used to line the thermæ, so that an air space between them and the wall should prevent the absorption of the water by the latter.

Tiles are extensively used in Europe for various purposes,—roofs, gutters, pavements, drains, house siding, lining flues, and furnaces, etc. They assume many forms; some have a local character, others are made in imitation of the antique.

*Plain tiles* are usually made ⅝ inch in thickness, 10½ inches long, 6¼ wide. They weigh from 2 to 2½ pounds each, and expose about one half to the weather. 740 tiles cover 100 superficial feet. They are hung upon the lath by two oak pins, inserted into holes made by the molder.

*Plain tiles* are now made with grooves and fillets on the edges, so that they are laid without overlapping very far, the grooves leading the water. This is economical of tiles, and saves half of the weight, but is subject to leak in drifting rains, and to injury by hard frosts.

Fig. 6432.

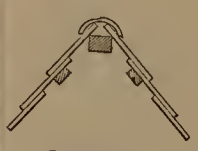
*Pan-Tiles.*

*Pan-tiles*, first used in Flanders, have a wavy surface, lapping under and being overlapped by the adjacent tiles of the same rank. They are made 14½×10½; expose 10 inches to the weather; weigh from 5 to 5¼ pounds each; 170 cover 100 superficial feet.

*Crown*, *ridge*, *hip*, and *valley* tiles are semi-cylindrical, or segments of cylinders used for the purposes indicated.

A *gutter*-tile has been introduced in England, forming the lower course, being nailed to the lower sheathing board or lath.

Fig 6433.



*Ridge-Tile.*

Fig. 6434.

*Gutter-Tiles.*

*Siding*-tiles are used as a substitute for weather boarding. Holes are made in them when molding, and they are secured to the lath by flat-headed nails. The *gage*, or exposed face, is sometimes indented, to represent courses of brick. Fine mortar is introduced between them when they rest upon each other.

*Siding-tiles* are sometimes called *weather-tiles* and *mathematical tiles*; these names are derived from their exposure or markings. They are variously formed, having curved or crenated edges, and various ornaments either raised or encaustic.

Modifications of the pan-tile are shown in the examples *a b* (Fig. 6436), the edges being turned up and down respectively. *c d e* are modifications of the ridge-tile, in which the gutter and ridge are placed alternately.

*f g* show modes of securing. The former is molded with a

lug, which catches above the lath of the roof to hold itself in position. *g* shows a tile molded with two lugs, by which it engages the tiles of the courses above and below.

Fig. 6435.

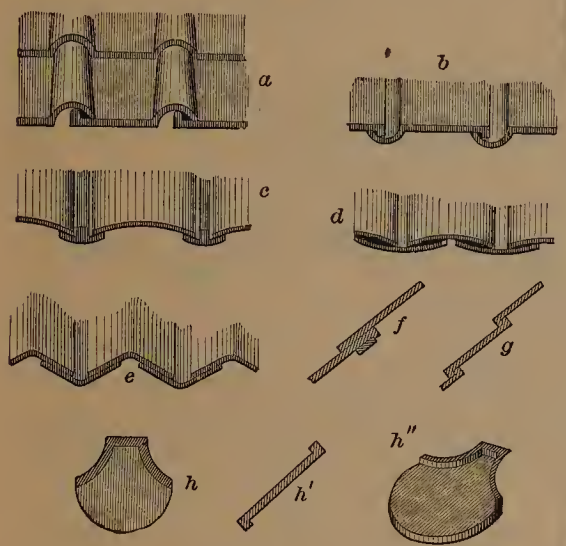
*Siding-Tiles.*

*h h' h''* are elevation, section, and perspective views of a tile exposing a semicircular face to the weather. The semicircular portion has a drop-flange which catches over the re-entering curves of the upper part, these curves having upturned flanges for that purpose.

The glazed tiles are inferior to slate, as they imbibe about $\frac{1}{7}$ their weight of water, and tend to rot the lath on which they are laid. Good slate only imbibes $\frac{1}{200}$ part of its weight, and is nearly water-proof.

The *tile* is somewhat celebrated in an artistic sense, as forming the cover of the basket of keepsakes placed by a nurse upon the tomb of a Corinthian maiden. Being placed over an acanthus root, the basket became inclosed by the foliage, which turned gracefully over when it met the tile, and suggested to Callimachus the Corinthian capital. Such is the story, and it is pretty enough to believe upon a moderate amount of evidence.

Fig. 6436.




*Tiles.*

*Encaustic* tiles; ornamental tiles in which the colors are burned in. See page 801.

*Galvanized* iron tiles have been introduced in France. They are shaped like pan-tiles, so that each laps upon its neighbor in the course, as well as the lapping of each course upon the one beneath it.

The metal being thin, the tiles are easily cut to fit a sloping line of roof, corners, etc.; and they are fastened by a single nail of galvanized iron, with which is used a small leaden washer, to render the nail-hole perfectly tight.

2. (*Brass-founding.*) The cover of a brass furnace. Now made of iron, but formerly a flat tile. See BRASS-CASTING.

3. (*Metallurgy.*) A clay cover for a melting-pot.

**Tile-creas'ing.** (*Masonry.*) A row of tiles laid along the top of a wall, projecting beyond the face; or each face, if both are exposed. A row of bricks laid *header* fashion is laid above, and is called a *cope*. This is *plain* tile-creasing. A double row laid so as to break joint is double tile-creasing.

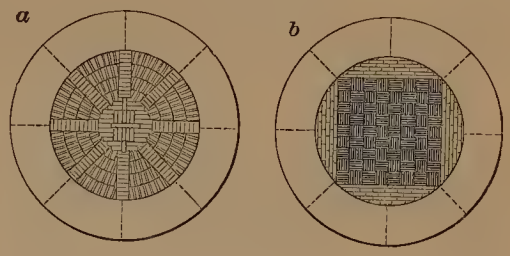
**Tile-drain.** One made of baked earthenware.

**Til'er.** A tile-kiln.

**Tile-kiln.** A form of kiln adapted to *burning* tiles.

A good form of tile-kiln, as used in Staffordshire, England, is shown in the accompanying figure. On the bottom of the oven are first placed 2,000 bricks, as shown at *a*, which is a plan of the oven as seen when eight courses of brick are laid edgewise. The eight rows, with twelve bricks in each, as seen in the plan, cover a space left in continuation of flues from the eight fire-holes. The bricks in the first seven courses are so placed as to leave a flue of an average width of 4 inches. The dotted lines show the position of the fire-holes. Upon these bricks are placed 7,000 tiles, forming a square, the spaces between the

Fig. 6437.



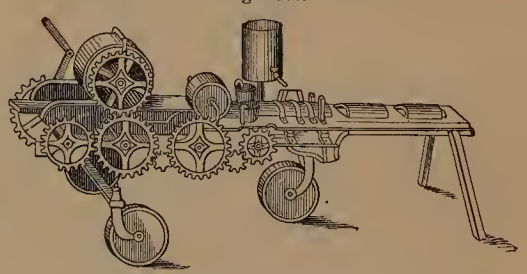

*Tile-Kiln.*

*a*, plan of brick courses. *b*, plan of tile courses.

tiles and the curved sides of the oven being filled up with bricks, as seen in the figure. *b* is a plan of the oven as seen when the first course of tiles are placed upon the bricks, seen in the figure *a*. The tiles are placed in bunches of twelve, and laid alternately cross and lengthwise; the nib on each tile spaces it from its neighbor and supports it in vertical position. The spacing of the bricks and tiles allows the circulation of the heat between them, and the circular oven is found well adapted to secure uniformity of heat.

The kiln is protected on the windward side, to prevent uneven urging of the fires. The oven being *set*, the doorway is bricked up and daubed, the fires kindled and kept burning, moderately at first, and then more freely. The usual time for firing is thirty-eight hours, and the consumption four tons of coal for a kiln of the size described. Three days are then allowed for cooling, and they are afterward taken out of the kiln. Those tiles which are to be made of a grayish color are thus treated. It having been ascertained that the tiles are burnt enough, and while still red-hot, a quantity of small fagots of green alder with the leaves on is introduced into each flue. The flue-holes are then well secured, and the holes in the roof each stopped with a paving tile, and the whole surface is covered with four or five inches of sand, on which a quantity of water is thrown, to prevent the smoke from escaping anywhere. It is this smoke which gives the gray color to the tiles, both internally and externally. The kiln is then left closed for a week, when the sand is taken off the top, the door and roof-holes are opened, as also the flue-holes, and the charcoal produced by the fagots taken out. Forty-eight hours after, the kiln is cool enough to allow of the tiles being taken out, and the kiln charged again. Whenever any of the tiles are to be glazed, they are varnished after they are *baked;* the glaze being put on, the tiles are put in a potter's oven till the composition begins to run. The glaze is generally made from what are called lead ashes, being lead melted and stirred with a ladle till it is reduced to ashes or dross, which is then sifted, and the refuse ground on a stone and resifted. This is mixed with pounded calcined flints. A glaze of manganese is also sometimes employed, which gives a smoke-brown color. Iron filings produce black; copper slag, green; smalt, blue. The tile being wetted, the composition is laid on from a sieve.

Fig. 6438.



*Hunt's Tile-Machine.*

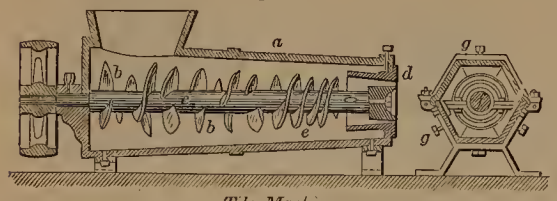
**Tile-lay'ing Plow.** A mole-plow invented by J. Fowler, Jr., England, about 1850, in which the mole was made to draw in a succession of drain-tiles strung upon a rope. See MOLE-PLOW, Fig. 3207, page 1469.

**Tile-ma-chine'.** Drain-tiles are either molded flat and bent around a former to the proper shape, or are made at once of a curved form by pressing the clay through a *dod* or mold of the required form. The latter plan is now usual.

Hunt's machine (Fig. 6438) has two iron cylinders, around which webs of cloth revolve, whereby the clay is pressed into a slab of proper thickness without adhering to the cylinders. It is then carried between two vertical rollers, which impart a

semi-cylindrical or other required shape, after which the tiles are polished and finished by passing through three iron molds of horseshoe form, being at the same time moistened by the dripping of water from a tank above, and finally conducted off upon an endless web.

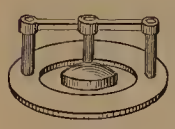
Fig. 6439.



*Tile-Machine.*

In more recent machines, the tiles are generally formed at one operation, by pressing. A charge of clay sufficient to form a number of tiles is placed in a cylinder and subjected to the action of a piston, which forces it out as a continuous tube through the *dod* (Fig 6440), after which it is cut into lengths by a wire.

Fig. 6440.

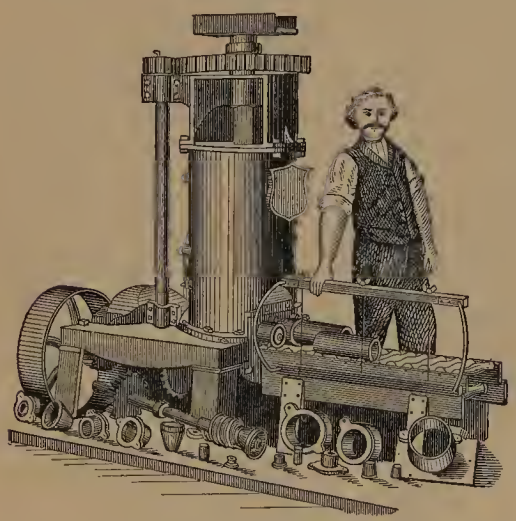


*Dod.*

The most modern machines generally employ a screw, which serves at the same time to mix the clay and force it through the mold; the process of feeding and molding is thus rendered continuous, no time being lost in charging the cylinder. See also Fig. 1746, page 741.

Tiffany's (Fig. 6441) consists of a vertical pug-mill containing rotary curved knives and a screw-follower for forcing the clay through the dies, an assortment of which are shown at the base

Fig. 6441.



*Tiffany's Tile-Machine.*

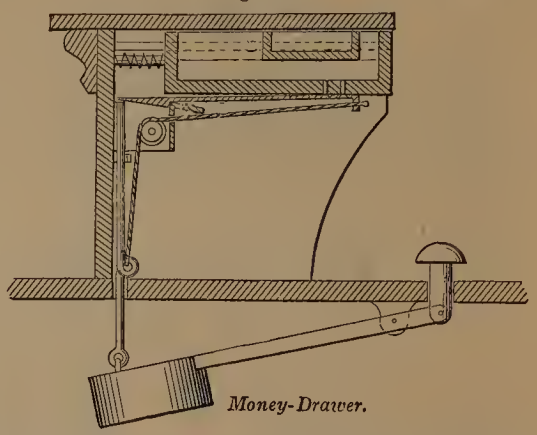
of the apparatus. The pipe, on issuing from the dies, is carried forward by a series of rollers having hollowed surfaces, and is cut into lengths by a rocking frame provided with cross wires. In another machine, the clay is forced through the dies by two plungers working in boxes at the base of the pug-mill, and reciprocated by cranks set at right angles to each other on the same shaft; two sets of dies are employed; one plunger being retracted to allow its box to receive a supply of clay, while the other is engaged in forcing the clay through its die.

**Till.** A money-drawer in a counter or desk.

Fig. 6442 shows a shop-counter till, which is opened by pressure of the foot on a knob, which lifts a weighted lever and allows a spring to throw the door open. When the foot is withdrawn, the weight pulls the drawer shut.

**Till-a-larm'.** An attachment to drawers, especially to money or till drawers, to announce the surreptitious opening of the same. Some are simple, and are so attached as to strike an alarm whenever the drawer is opened, and consist of a bell and a spring hammer, the latter being tripped by the contact of a stud on the opening drawer. Other devices are more complicated, and only sound the alarm when the drawer is opened by one unacquainted with the specific devices which throw the alarm out of operation.

Fig. 6442.

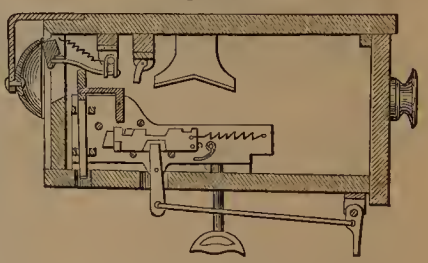


*Money-Drawer.*

There are many patents on till-alarms, some of which have complicated locks and secret devices, which cannot be briefly explained within the limits assigned to this subject.

Fig. 6443 has a vertically sliding bolt, employed in connection with a series of notched tumblers, together with springs and catches, and with a catch-rod and plate, all so arranged that when the till is opened an alarm will be sounded upon the bell. By a secret trigger beneath the drawer, the bolt is withdrawn and the alarm-mechanism is undisturbed as the till is opened.

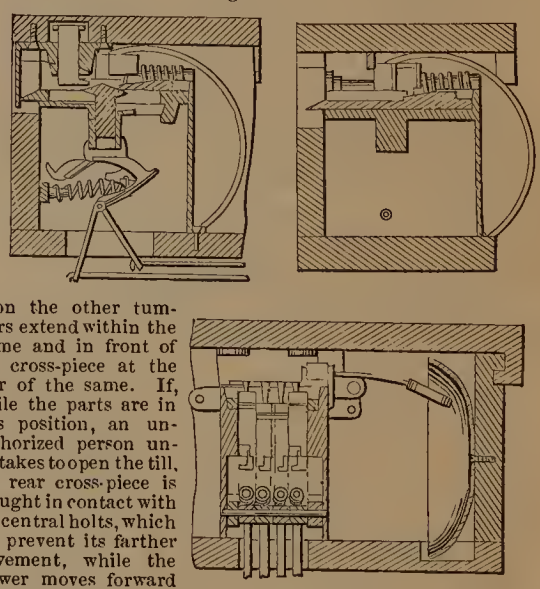
Fig. 6443.



*Purrington's Till-Alarm.*

Fig. 6444 is a till-alarm and lock. When the till is closed, the outer bolts which rest on the tumblers are raised above the upper surface of the frame, while the central bolts which rest

Fig. 6444.



*Till Alarm and Lock.*

upon the other tumblers extend within the frame and in front of the cross-piece at the rear of the same. If, while the parts are in this position, an unauthorized person undertakes to open the till, the rear cross-piece is brought in contact with the central bolts, which will prevent its farther movement, while the drawer moves forward until the flange is brought against the lug, which prevents farther movement of the till. If the till be now moved back, the alarm is sounded. See also Fig. 129, page 57.

**Till'er.** 1. A transverse handle at the upper end of a *pit* saw.

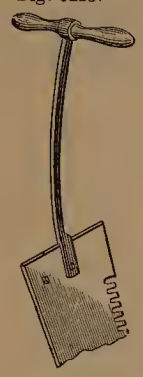
2. The handle of a cross-bow.

3. (*Nautical.*) The lever on the head of a rudder, and by which the latter is turned.

Rudders with tillers are shown in paintings of Edfou, Egypt.

**Till'er-rope.** (*Nautical.*) That connecting the head of the tiller with the drum of the steering-wheel.

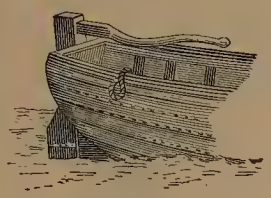
Fig. 6445.



*Tiller.*

**Till'er-wheel.** More properly termed *steering*-wheel, as it does not always act upon the rudder through the intervention of a tiller, which is a bar or lever projecting

Fig. 6446.



*Tiller.*

from the rudder-head or rudder-post. See STEERING-WHEEL.

Sometimes called a "pilot" wheel, as that functionary has it in charge in the ordinary steamboating on our rivers.

**Till-lock.** One adapted to money-drawers of counters. See TILL-ALARM.

**Tilt.** 1. (*Vehicle.*) *a.* A wagon-cover, usually of canvas on wooden bows.

*b.* The temporary cover for an artillery-carriage, corresponding to our *paulin* or *tarpaulin*, is called a *tilt* in the British service.

2. (*Nautical.*) An awning over the stern sheets of an open boat, supported by stanchions on the gunwale.

3. (*Machinery.*) A TILT-HAMMER (which see).

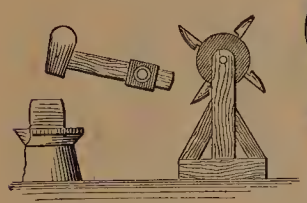
**Tilt'ed Steel.** Blistered steel heated in a furnace and subjected to the action of a tilt-hammer, which strikes about 700 blows per minute, and increases the solidity and tenacity of the metal.

**Tilt-ham'mer.** The word *tilt* is derived from a root which means a lifting or up-and-down motion, which is descriptive of the action of the hammer.

The hammer-stock is pivoted as a lever of the first or third order, and is acted upon by a *wiper-wheel*, whose cams or cogs tilt the hammer and then allow it to drop upon the bloom on the anvil.

Its particular use is in compacting the balls of iron as they come from the puddling-furnace, and driving out the dross with which the iron is associated when in the form of *pig*, and some of which is removed by the reverberating flames of

Fig. 6447.



*Tilt-Hammer.*

the furnace. It is also used in heavy forging.

In the first-mentioned use, the *squeezer* has to some extent superseded it; and in the latter line, the atmospheric and steam hammers — especially the latter — have entirely dispensed with the *tilt* motion when very heavy forgings are under treatment. See STEAM-HAMMER; STEEL-PRESS; FORGING.

A number of other power-hammers are reciprocated in vertical lines by other means than piston and cylinder. A list will be found under HAMMER.

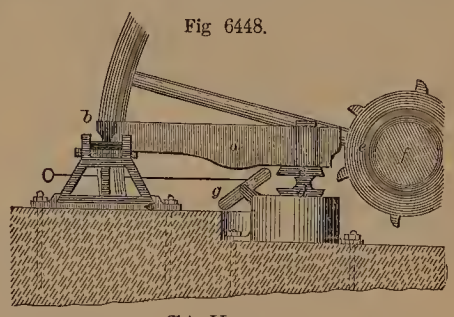
The ordinary tilt-hammer (Fig. 6448) has a cast-iron helve *a* supported at the end *b* on plummer-blocks, fixed upon wooden beams to ease the jar. The head *c* is of wrought-iron, faced with steel, passes through an eye in the helve, and is secured by a key. The base of the anvil is of cast-iron, and the *pane d* of wrought-iron, faced with steel. The head is raised by a series of cams upon a cast iron collar *e*, called the *cam-ring bag*, fixed on the shaft *f*, which is provided with a heavy fly-wheel

The hammer has usually a drop of 16 to 24 inches, and strikes 75 to 100 blows per minute When not in use it is propped up by the support *g*. See TRIP-HAMMER; STRIKER; STEAM-HAMMER. See list under HAMMER.

The cushioned hammer shown in Fig. 6449 (Butterfield's pateut) is made of iron, except the helve. The anvil and anvil-block are cast-iron, made separate and adjustable. The latter has a separate foundation, independent of that of the main bed.

The balanced helve swings upon two hardened adjustable steel centers, and is put in motion by the use of a broad adjustable steel eccentric operating in connection with the working-beam and rubber cushions, the length of stroke being governed by the adjustable eccentric; the force and power of the blow is greatly influenced by the reactive and united action of the cushions, which so far absorb the jar that a person holding his

Fig 6448.




*Tilt-Hammer.*

hand upon the working parts, when under the most rapid and violent motion, cannot identify the strokes of the hammer.

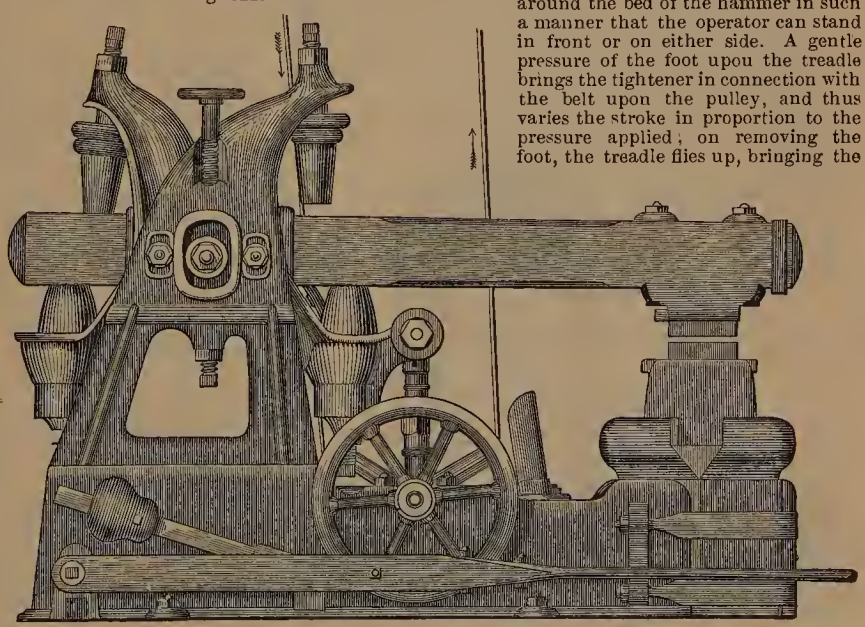
The cushions do the double work of relieving the frame from jar and giving force and power to the blow.

Tension can be given each cushion by raising or lowering the set-screws in the upper and lower sockets of the working-beam; the helve is placed in position and adjusted to any stroke or sized die by the use of set-screws where the same is attached to the frame; the husk is also adjusted to the helve in the same manner.

The object of raising or lowering the husk is to enable the operator to use different thicknesses of dies, or adjust it to the same dies after grinding, etc.

The power is applied and regulated by the use of a foot-treadle running around the bed of the hammer in such a manner that the operator can stand in front or on either side. A gentle pressure of the foot upon the treadle brings the tightener in connection with the belt upon the pulley, and thus varies the stroke in proportion to the pressure applied; on removing the foot, the treadle flies up, bringing the

Fig. 6449.



*Bradley's Cushioned Hammer.*

brake upon the balance-wheel, stopping it instantly, leaving the hammer up, as it cannot stop with the dies closed.

**Tilt'ing-fil'let.** (*Roofing.*) The strip, $2\frac{1}{2} \times \frac{3}{4}$ inch, and chamfered to an edge, laid down around the edge of a roof where the edges of the shingles or slates abut upon a wall. The object is to avoid leakage at the arris. An *arris-fillet.*

**Tilt-mill.** (*Metal.*) A building where a *tilt-hammer* is used.

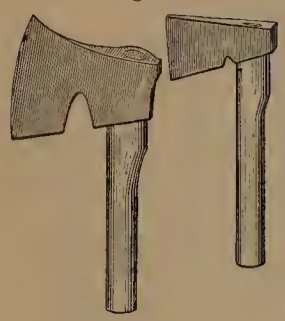
**Tilt-roof.** A round-topped roof, shaped like a *tilt* or wagon-cover.

**Tim'ber.** 1. (*Carpentry.*) A piece of wood in a frame. See BEAM; GIRDER; BRACE; TIE; JOIST; POST; PLATE; PURLIN; STRUT; etc. See list under CARPENTRY.

2. (*Shipbuilding.*) One of the curved frames which form the ribs of a ship. They are built up of several pieces: the *floor-timbers* are between the *keel* and *keelson*, and the outward and upward extension-pieces are *futtocks*, first, second, third, etc. The portions extending above the deck-level are the *top* timbers. See FRAME, Fig. 2093.

*Cant* timbers are placed obliquely on the keel.
*Filling*-timbers are to fill up between the frames.
*Knuckle*-timbers are the foremost in the bow.
*Fashion*-pieces, the hindmost in the quarter.
Each timber-frame comprises:—
The *cross-piece*, or half-floor.
The several *futtocks.*
The *top timber.*
The *lengthening-piece* (if necessary).
Their upper ends are capped by the *rough-tree rail.*
The lower end is mortised into the keel.
The *skin*, inner and outer, is bolted, nailed, or tree-nailed to the timbers.
Each course on the outside is a *strake.*
Thick *strakes* are *wales.*
To the chainels (*chain-wales*) the *shrouds* and *back-stays* are connected.

Fig. 6450.



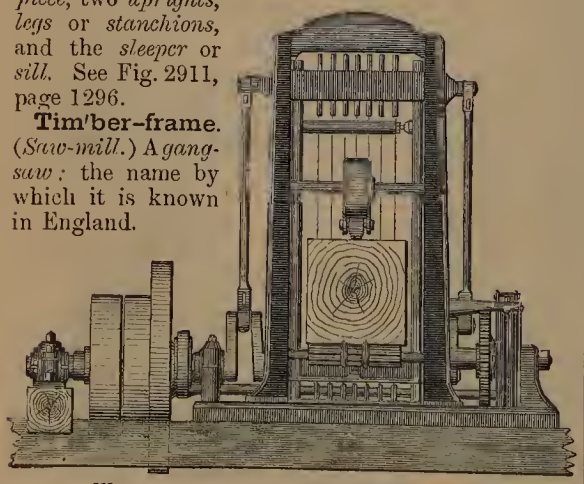
*Timberer's Axe.*

**Tim'ber and Room.** (*Shipbuilding.*) The width of a timber and a space. Also called *room* and *space*, or *berth* and *space.*

**Tim'ber-bridge.** See WOODEN BRIDGE; also list under BRIDGE.

**Tim'ber-er's Axe.** (*Mining.*) An axe or hatchet of the mine-carpenter, used in chopping to length and notching the timbers which support the roof and sides of the gallery or drift. A set of timbers consists of the *cap* or *head-piece*, two *uprights*, *legs* or *stanchions*, and the *sleeper* or *sill.* See Fig. 2911, page 1296.

Fig 6451.



*Worssam's Timber-Frame (End Elevation).*

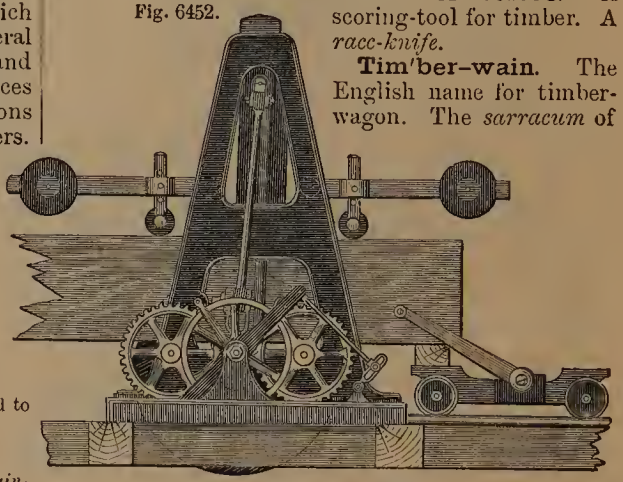
**Tim'ber-frame.** (*Saw-mill.*) A *gang-saw*: the name by which it is known in England.

Worssam's (Figs. 6451, 6452) comprises an iron sole-plate bolted to a timber framing and carrying upright standards. It has a swing-frame carrying a gang of saws and reciprocated by two connecting-rods, which vibrate outside of the main standards by the action of a double-throw crank-shaft. The timber is propelled to the saw on rollers, top-pressure rollers being provided to keep it well down. The ends of the timber are supported and guided by carriages running on rails back and front of the machine. See also Plate LIV., page 2042; Fig. 2157, page 942.

**Tim'ber-head.** (*Shipbuilding.*) So much of a frame-timber as rises above the deck.

**Tim'ber-hitch.** (*Nautical.*) The end of a rope is taken round a spar, led under and over the standing part, and passed two or three turns round its own part, making a jamming-eye.

Fig. 6452.



*Timber-Frame (Side Elevation).*

**Tim'ber-scribe.** A scoring-tool for timber. A *race-knife.*

**Tim'ber-wain.** The English name for timber-wagon. The *sarracum* of Juvenal. Shown on the Trajan column.

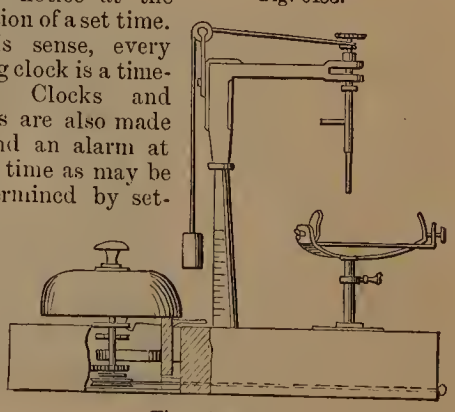
**Tim'bre.** Fr. (*Music.*) The *quality* of tone distinguishing voices, instruments, and stops, irrespective of *pitch* or intensity.

All the notes of a given stop of an organ have of necessity the same *timbre*, but in pitch they range throughout the extent of the chromatic scale. Corresponding notes, of *stops pitched in unison*, such as the *open diapason*, *dulciana*, *trumpet*, *bassoon*, *cremona*, *vox-humana*, have the same pitch, but each differs from the others in *timbre*: the *quality* of the tone is different. This difference is attained in various ways. Some of the pipes have wooden mouth-pieces, others metallic mouth-pieces, reed pipes, reeds of varying qualities, tubes of varying proportions and shapes, to imitate the peculiar sounds of the various instruments after which they are named, as *flute*, *trumpet*, *bassoon*, *oboe*, etc.

**Tim'brel.** A drum or tambourine used in ancient times. We read of it in Exodus and Job. Miriam sang, danced, and played on the timbrel when she took her part in the grand antiphonal by the Red Sea. See TAMBOURINE; TABRET.

**Time-a-larm'.** An audible notice at the expiration of a set time. In this sense, every striking clock is a time-alarm. Clocks and watches are also made to sound an alarm at such a time as may be predetermined by set-

Fig. 6453.



*Time-Alarm.*

ting the machinery therefor. (See ALARM-CLOCK.) The term is, however, specifically applied to a device to waken sleepers; in some cases it goes so far as to fire a pistol, strike a match, light a candle, and upset the bed, or empty a pitcher of water into the face of the sleeper. Strange how much trouble some people will take not to rest easy!

In Fig. 6453, the weight is elevated by coiling its supporting cord upon the shaft, and is raised so high that when the shaft is connected to the spindle of the minute-hand, the required time shall elapse before the weight descends sufficiently to depress the detent of the alarm. A scale on the post indicates the hight to raise the weight.

**Time-ball.** A ball on a pole, dropped by electricity at a prescribed instant of time. An *electric time-ball*. It is used especially in maritime cities to give time to the officers of the ships in port.

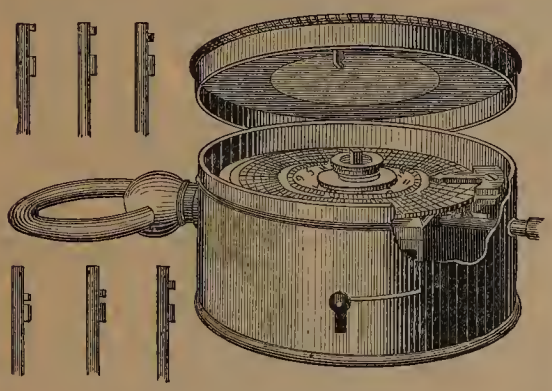
**Time-can'dle.** One in which the size and quality of the material and the wick are so regulated that a certain length will burn in a given time. Candles colored or indented at certain intervals so as to mark time were patented in England in 1859.

In Asser's Life of Alfred the Great it is stated that the king had for his daily use six tapers, each 12 inches long and containing 12 dwts. of wax, and divided into 12 parts or inches, of which three would burn in one hour. To prevent flaring and irregular consumption, he shielded the light by thin plates of horn, making a lantern. See LANTERN.

**Time-de-tect'or.** An instrument for recording the time at which a watchman may be present at different stations on his beat.

It is a kind of large strong watch, which is carried by the watchman, and is provided with several keys, differing some-

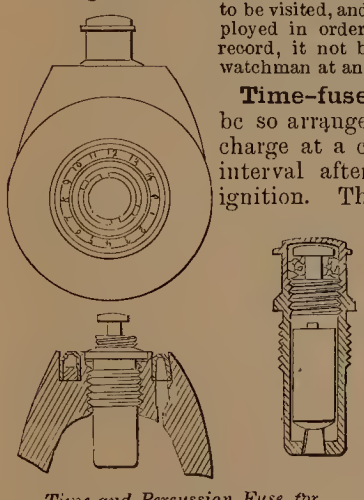
Fig. 6454.



*Time-Detector.*

what from each other, and each adapted to operate a marker appropriate to itself alone, and which leaves an imprint on its own particular circle of the dial; one of these keys is secured at each station to be visited, and that one must be employed in order to leave the proper record, it not being accessible to the watchman at any other point.

Fig. 6455.



*Time and Percussion Fuse for Explosive Shells.*

**Time-fuse.** A fuse which can be so arranged as to explode a charge at a certain determinate interval after the time of its ignition. This is usually effected either by cutting out or off a portion of the fuse or by employing compositions of which given lengths burn at different rates.

Fig 6455 shows a "Borman" fuse, which at the discharging point is in contact with a chamber containing quick powder, and communicating with the interior charge of the shell. See also FUSE, Fig. 2132, and pages 928, 929.

**Time-keep'er.** (*Horology.*) A watch or clock. See HOROLOGICAL INSTRUMENTS, list, pages 1123, 1124.

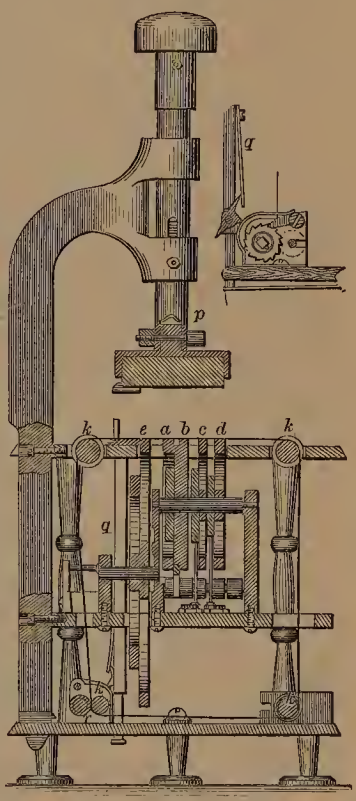
**Time-lock.** A lock having clock-work attached, which, when wound up, prevents the bolt being withdrawn when locked, until a certain interval of time has elapsed, even by means of the proper key. Various devices may be employed for this purpose; in one, a circular stop-plate rests against the end of the bolt and resists its withdrawal until pushed away by the movement of the train at the end of the time to which it was wound up. See ALARM-CLOCK, page 57.

**Ti-men'o-guy.** (*Nautical.*) A rope made fast to an anchor when stowed, to keep ropes from fouling on it.

**Time'piece.** An instrument for indicating time. See CLOCK; WATCH; CHRONOMETER; CLEPSYDRA; HOUR-GLASS; DIAL. See list under HOROLOGICAL INSTRUMENTS, page 1123.

**Time-print'ing Ma-chine'.** An apparatus for imprinting on a letter, dispatch, or other document the time at which it was sent, received, filed, etc. Adapted for use in telegraphic or other offices where numerous records of this kind have to be made.

Fig. 6456.




*Hinchman's Time-Printing Apparatus.*

Fig 6456 is a stamping-apparatus which automatically records the time of each impression made upon it. It comprises a clock provided with a minute-wheel having 60 teeth, which, through the medium of a lever having at one end a spring nib which has a limited freedom of movement in one direction, acts upon a ratchet-wheel also having 60 teeth, and borne upon the same shaft with the plain wheel *e* on which the minutes are engraved. A pin on this wheel at the expiration of each hour strikes a pawl-lever, which rotates a wheel *a*, having the hours engraved on its periphery; to this is affixed a wheel *b* having 24 divisions, 12 marked A. M. and 12 marked P. M. *c* is a wheel numbered from 1 to 31, corresponding to days, and *d* a wheel having the months engraved on its circumference; these two wheels are adjusted by hand. An endless ribbon passes over the faces of the wheels *a b c d e* around rollers *k k k k*, and is inked by contact with the inking-roller *r*. Impressions are made by the hand-stamp *p*, which at the same time depresses a pawl-rod *q* that engages a ratchet-wheel *s*, causing the lower left-hand roller to rotate and feed the ribbon.

In this device the clock-work only acts upon the printing mechanism for an instant in each minute, so that no shock is communicated to the former in the act of stamping.

In another machine a time-piece, provided with minute, hour, and calendar wheels, having raised figures and letters on their edges, arranged in line side by side, and operated from the time-piece by a pawl and armature lever of a magnet, is combined with a suitable inking and spring-plate device, so that the time and date may be at any time printed, either by a hand-pad or by the action of a second electro-magnet.

In a third machine by the same inventor, the type-dials are

concentrically arranged in a horizontal plane, and are operated by bevel-gears connected with the main shaft. Each revolution of the minute-dial moves the hour-dial one space, while one revolution of the latter moves the vertically arranged meridian-wheel and the disk indicating the day of the month each one space, and the latter in turn moves the month-disk. When the platen is depressed to make an impression, and the rotation of the shaft is suspended, the clock-movement winds up a spring within one of the cog-wheels connecting said shaft with that of the clock, which spring, as the shaft is released, communicates to it its lost motion.

**Tim'er.** A watch which has a seconds-hand, revolving once in a minute, and a counting hand which records minutes. It has a projecting pin which, when pressed, causes the hand to *fly back* to zero, and remain there till the pressure is removed. A form of *stop*-watch, keeping not actual time, but the time between events, such as the starting and arrival time in a race.

**Time-sig'nal.** A means of indicating the local time at an observatory to observers at one or several distant points.

Dropping a ball (*time-ball*) at a fixed hour, 1 o'clock, P. M., or mean noon daily, has long been in use in maritime cities and observatories. This serves as a means of regulating or ascertaining the rate of clocks or chronometers at all points where the falling of the ball is visible.

The electro-magnetic telegraph has been used for operating time-signals at much greater distances; thus, the Greenwich time is indicated at Liverpool and other cities in England by the dropping of a ball by means of an electric circuit operated from Greenwich, the circuit being automatically closed at one o'clock. The ball is dropped through the intervention of a series of levers, to one of which, acting as a detent, the armature of an electro-magnet, made so by the closing of the circuit, is attached. When this is attracted by closing the circuit, the detent is withdrawn and the ball falls.

By galvanometers placed in the circuits of the time wire to Liverpool, and the return wire, it was ascertained that the time elapsing between the receipt of the current in London and the discharge of the ball in Liverpool was $^{11}/_{20}$ of a second; of this $^{2}/_{20}$ were occupied by the automatic circuit-closer, $^{4}/_{20}$ by the ball-trigger mechanism, leaving $^{5}/_{20}$ of a second for the passage of the current by the underground wire.

By means of an improved arrangement devised by Mr. Varley for connecting the observatory at the Cape of Good Hope with time-balls at Simonstown and Port Elizabeth, the time elapsing between the passage of the current at Capetown and that announcing the falling of the ball at Port Elizabeth, 500 miles distant, is found to be but $^{1}/_{15}$ of a second.

**Time-ta'ble.** 1. A table giving the times of starting and arrival at each station of the daily trains on a given road.

2. A record of time of employés.

3. A board divided by vertical and horizontal lines representing time and distance respectively, and used to denote speed of trains. See SPEED-RECORDER, Fig. 5373, etc.

**Tim'ing.** (*Machinery.*) The regulation of the parts of a machine so that all the motions shall take place in due order and time. This may be illustrated in the sewing-machine, in which the stroke of the needle, the shuttle, and the feed take place necessarily in an exact sequence.

**Tim'ing-ap'pa-ra'tus.** (*Railway.*) An apparatus for automatically recording the rate of speed of railway-trains.

An endless screw on the axle of a car through the medium of a worm-wheel and connecting-rods causes a pencil-point to traverse back and forth across a strip of paper winding over a drum moved by clock-work. The paper is ruled with transverse lines corresponding to minutes, and the rate of speed is indicated by the number of lines which the pencil-mark crosses during its passage from one side of the strip to the other. Thus at the rate of 15 miles an hour, the diagonal pencil-line will cross four of the ruled lines; at 20 miles, three; and so on. When the train is stopped, the pencil-mark will be directly across the paper, parallel to the ruled lines. See SPEED-REGISTER; SPEED-RECORDER; etc.

**Tim'pa-no.** A drum. See TYMPANO.

**Tim-whis'key.** A heavy, lumbering, low-wheeled carriage.

**Tin.** Equivalent, 59; symbol, Sn. (*stannum*); specific gravity, 7.29; fusing-point, 442° Fah. A malleable, fusible, soft, white, lustrous metal, not readily corroded by atmospheric influences.

The bichloride is used as a mordant.

Tin forms an ingredient in most of the white alloys, such as solders, Britannia metal, pewter. See ALLOY.

Iron plate is tinned to prevent its oxidation, and the tin plate — as it is then called — is used for numerous purposes in and about the house, from the roof and eave-spouting to the culinary vessels in the kitchen.

*Kassiteros* (Gr.) is the ancient Sanscrit word *Kastira; Zinn*, in Germau; *dèn*, in Icelandic; *tin*, in English; *tenn*, in Swedish: answering to the Malay and Javanese *timah*. The names of articles of commerce become widely distributed; as the Sanscrit '*sarkara* and *kanda*, whence our *sugar* and *candy*. The old German word *glessum*, amber, has become the modern *glass;* the latter resembles the former very closely.

"Through the intercourse which the Phœnicians, by means of their factories on the Persian Gulf, maintained with the east coast of India, the Sanscrit word *kastira*, expressing a most useful product of Further India, and still existing among the old Aramaic idioms in the Arabian word *kasdir*, became known to the Greeks even before Albion and the British Cassiterides had been visited." — HUMBOLDT.

The position of the *Cassiterides*, or "Tin" islands, referred to by Herodotus, Book III. Chap. 115, was kept secret by the Phœniciaus, who had been dealing with the Celtic natives of Cornwall and Ireland for many centuries, introducing among them many of the weapons and implements which are found in their barrows and hogs. Strabo, Polybius, and Diodorus, each has his guess as to the geographical position of the islands. The trading for tin seems to have been conducted at St. Michael's mound in Cornwall, to which place it was carried in carts across the sands when the channel was dry at low tide.

A rude, smelted block of tin was found some years since at Ladock, near Truro, Cornwall, supposed to have been smelted at the time when the Phœnicians traded with ancient Cornubia, and is in the Truro Museum. It is about 2 feet 11 inches long, 11 inches broad, and 3 inches thick.

Strabo says: "The people live by their cattle, and have mines of tin and lead; these metals they exchange for pottery, salt, and bronze implements."

Ptolemy, Pliny, Solinus, and P. Mela referred to the islands.

Fig. 6457.

*Phœnician Pig-Tin.*

The metal is believed to have been brought to the Mediterranean, from the Malay islands to India and Arabia, in early times.

Tin is mentioned in the Bible in the books of Numbers, Isaiah, and Ezekiel. The latter mentions it as coming from Tarshish to Tyre, probably Tartessus, now Cadiz, where there was a famous Phœnician colony, and where the trading-vessels from the Cassiterides would naturally call.

Tin is first mentioned as among the spoil of the Midianites, 1452 B. C., when the five kings of Midian and the recalcitrant Balaam were slain. Gold, silver, brass (? copper), iron, tin, and lead were among the spoils, and the tribes also received an accession of 32,000 young females.

The tin was probably obtained from the intercourse of the Midianites with Phœnicians. The sources of supply from the Indian Archipelago were not then opened to the Mediterranean countries.

Tinning was practiced by the Romans. Pliny says: —

"Stannum illitum æncis vasis."

Dripping-pans have been found at Herculaneum plated with silver.

The tin of commerce is derived from the native oxide, which is found in Cornwall, Malacca, the island of Banca, Germany, Bohemia, Hungary, Australia, Chili, and Mexico.

Five kinds of metallic tin are found in the market, known as Banca, Straits, English, Spanish, and Australian. The first, derived from the island where it is produced, is the purest and best. Straits tin comes from Singapore, Borneo, and other places adjacent to the Malayan peninsula, and ranks second. The English tin ranks third; the better qualities, however, which are retained for home consumption, equalling the Banca. Spanish tin comes from Mexico and South America; it is badly refined, and commands a less price than either of the others. The provinces of New South Wales and Queensland, Australia, now furnish immense quantities.

The tin of Cornwall is principally derived from the peroxide; the tin stone is found in veins associated with copper ores in granite and slate rocks, in which case it is called *mine tin*. It is also met with as an alluvial deposit mixed with rounded pebbles, and is termed *stream tin*. When occurring in reniform masses or wedge-shaped pieces with concentric bands, giving it a ligneous appearance, it is termed *wood tin*.

The ore is broken with a hammer into pieces about the size of a man's fist, crushed in a stamp-mill, and then undergoes a number of washing and separating processes depending on its quality and condition, such as *buddling*, *tossing* or *tozing*, *chim-*

*ming*, *dilluing*, *vanning*, *jigging*, *trunking*, *framing* or *racking*, and *tying*, the latter being generally performed after roasting.

The ore having been thus prepared is roasted in a reverberatory furnace to get rid of the sulphur and arsenic. The latter is collected in chambers and resublimed to form the white arsenic of commerce. The calcined ore is then washed to remove the impurities. If it contain copper pyrites, it is exposed for some time to the atmosphere and again washed, in order that the oxygen may convert the pyrites into a soluble sulphate. If copper be present, the calcined ore may be treated with dilute sulphuric acid, which dissolves the copper without attackiug the tin.

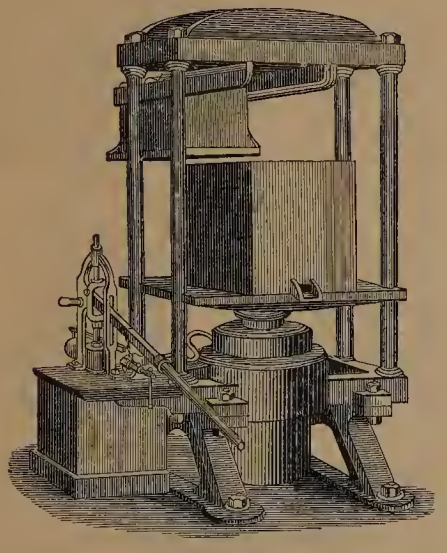
After washing, the ore is called *black tin*, aud is ready for smeltiug This process is conducted in a reverberatory furnace, with common pit-coal, anthracite or other carbonaceous substance being mixed with the ore to produce an ordinary quality of metal; but if very pure metal is desired, a blast-furnace, with charcoal for fuel, is used. In the former case the ore, mixed with about $^1/_5$ its weight of powdered coal or anthracite, and a little slaked lime or fluor spar, serviug as a flux for the silica present, is placed upon the floor of the furnace and slightly sprinkled with water. During the first six or eight hours the doors of the furnace are closed, and the heat gradually increased. The door is then opened, and the fused mass worked with a long iron paddle to separate the slag.

The molten metal is then drawn off by removing a clay plug from the tap-hole, and flows into a basin. The slags are divided into three classes, one of which is thrown aside, a second restamped and worked, and the third smelted with the succeeding charge. The tin thus produced is refined, by liquation, or slow fusion iu a reverberatory furnace, the dross floating on the surface while the tin is drawn off; billets of green wood are then lowered into the molten metal and allowed to remain for some three hours; these cause the lighter remaining impurities to rise in the form of a scum to the surface, the heavier ones subsiding toward the bottom. Three strata are thus formed: the upper, being most pure, is termed refined; the lowest most impure, and the middle medium. Each is ladled out into iron molds, forming what is known as *block-tin*. The refined is used principally for tin-plate.

The *blowing-house* is often employed, where charcoal is cheap, for producing a fine quality of tin. In this the ore is smelted in a blast-furnace, and the metal refined by poling with green sticks of wood.

*Grain-tin* is prepared by plunging blocks of tin into a bath

Fig. 6458.



*Tincture-Press.*

of molten tin, and when they have assumed a brittle crystaling texture, they are broken with a hammer; or, after being heated nearly to the fusing-point, they are allowed to fall from a considerable hight; they are thus broken up into elongated grains.

**Tin Can.** The ordinary name for the cans of tinned iron now so widely used.

One of the great improvements in this branch of business was the tin can of Masury, in 1859, in which he made a portion of the cover of very thin metal, which could be readily cut through with a knife. 10,000,000 of these cans are made yearly, 10,000 being used daily by the Borden condensed milk company. The invention is largely used in the paint trade, as it enables paints to be put up in liquid form, ready for use, thereby saving the painters time and trouble in mixing paint. See CAN-SOLDERING MACHINE, and other titles under SHEET-METAL. For list, see PLUMBING AND SHEET-METAL WORK, page 1750.

**Tin-clip'pings.** See TIN-SCRAP.

**Tinct'ure-press.** An apparatus for thoroughly extracting the active principles of plants, etc., by submitting them to compression.

The example is worked by hydraulic power. The ram of the press lifts the table which supports the box in which the infused mass is contained. The platen is above the press, and is stationary during the operation of pressing, but is moved out of the way when filling and emptying the box.

**Tine.** A term properly applied to a prong which pierces, as in forks, whether for culinary or table use, or such as are adapted for hay or manure. It must not be confounded with *tooth*, as in the harrow, or the cylinder of a thrashing-machine, etc.; the action is different. The stirrers of other cultivators are known as *shovels*, *shares*, or *teeth*, according to form and action.

**Tin-foil.** Very thin sheet-tin; often alloyed.

**Tin-fur'nace.** Tin-ore is broken into pieces with small hammers, and the pieces of spar thrown aside. The ore is then crushed between rollers, *jigged*, to separate the tin-stone from the refuse, then stamped and washed.

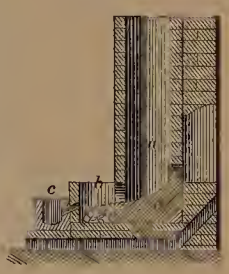
The crushed and washed ore is calcined in furnaces, to get rid of arsenic and other volatile impurities. It is then mixed with powdered culm or anthracite coal, and put in another furnace. The heat expels other impurities, the earthy matters float, and the metal is drawn off at a tap-hole.

In the subsequent refiniug process, the remaining impurities are gradually eliminated, and the refined tin is east in granite molds in blocks of 300 pounds each. This is *block-tin*.

*Grain-tin* is obtained by granulating molten tin in water, from a second melting of blocks of a superior quality of metal.

Fig 6459 represents the furnace used at Altenberg, Saxony, for smelting roasted tin-ores. It is of granite, about 10 feet high. *a* is the shaft; *b*, the fore-hearth; *d*, the bottom stone; and *c*, an iron caldron for receiving the metal; a tuyere enters through *b*. The ore, mixed with coke, coal, or charcoal, and slag from former smeltings, is placed in *a*; the reduced tin collects first on the fore-hearth *b* and runs thence to *c*. In this state it contains iron and arsenic, from which it is purified by liquation; the pure tin, fusing more readily, oozes out and leaves a more infusible alloy behind.

Fig. 6459.




*Tin-Furnace.*

**Tin-glass.** The glass-maker's name for *bismuth*.

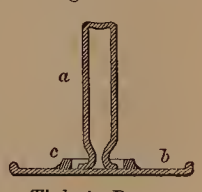
**Tin-glaze.** (*Pottery.*) An opaque glaze, or enamel, having oxide of tin as a basis, used upon majolica ware and other fine pottery.

Tin-glazes are found upon ancient Egyptian and Persian articles. The process appears to have been introduced into Europe by the Saracens; tin-glazed tiles manufactured about 1300 A. D. being found in the Alhambra. They also made very beautiful wares, known as Hispano-Moresque, recognizable by the peculiar metallic luster of their surface. These were imitated by the Italians in the well-known majolica ware. The earlier specimens of this have a lead glaze, and are termed half or "mezza majolica." Toward the close of the fifteenth century the Italians became possessed of the secret of making tin-glazes, and soon surpassed the work of their predecessors the Moors.

**Tink'er.** (*Ordnance.*) A small mortar on the end of a staff. See Fig. 1365.

**Tink'er's-dam.** A wall of dough raised around a place which a plumber desires to flood with a coat of solder. The material can be but once used; being consequently thrown away as worthless, it has passed into a proverb, usually involving the wrong spelling of the otherwise innocent word "dam."

Fig. 6460.




*Tinker's-Dam.*

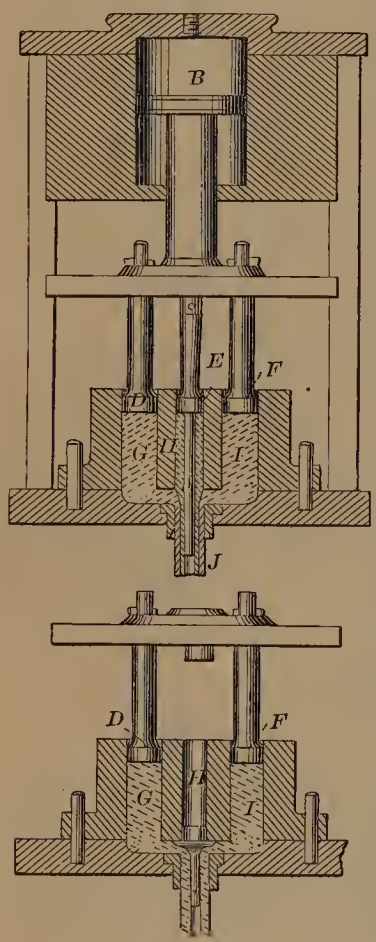
An electrophorus may be thus formed. A vial *a*, previously heated, is upset upon a circular plate *b* with a turned-over edge. A circular dam of dough *c* is raised

around the lip, forming a wall to hold the soft solder which holds the insulator-handle to the plate.

**Tin-lined Pipe.** Lead pipe is lined with tin in order to prevent the formation of deleterious salts by the action of the water on the lead. Although the action of pure water upon metallic lead when there is no access of air to the pipe is so slight as to be uninjurious, yet it is found in practice that, owing to various causes, all water used for domestic purposes containing air and more or less mineral impurities, the water after its passage through lead pipes is found to become charged to a greater or less extent with the poisonous salts of lead. Tin is much less subject to be thus acted on, and its salts are comparatively innocuous.

The earliest attempt to remedy this evil by lining the tin pipe with lead appears to be found in Alderson's English patent of January 26, 1804.

Fig. 6461.




*Machine for Making Tin-Lined Lead-Pipe.*

In this the lead was cast around a core or mandrel in a two-part mold, the mandrel was then withdrawn and replaced by a smaller one, around which the fused tin was poured. A reversal of the process was provided for, the tin lining being first cast, and the lead afterward poured around it. The compound pipe was afterward lengthened by being drawn out upon a mandrel. A method of drawing out the tin lining upon a mandrel, inserting it in a larger leaden tube, and drawing out the two together, is also specified.

The first specified methods are still generally followed, various improvements having been made in the details.

In Fig. 6461, the piston *B* of a hydraulic press serves to operate the central plunger *E* and the annular plunger *DF*. The former forces out the tin contained in the central cylinder *H*, and the latter the lead in the annular cylinder *G I*. *J* is the mandrel. The machine admits of being arranged for making pipes all of one metal, as in the lower portion of the figure.

In Fig. 6462, two or more cylinders *H H*, *K K* are employed. The hollow ingot of tin *B B* is placed on a mandrel and forced through the central opening previously made to receive it in the ingot of lead *A*. The pressure unites the two together, and the compound pipe is forced through a die and passes out through the opening *E*.

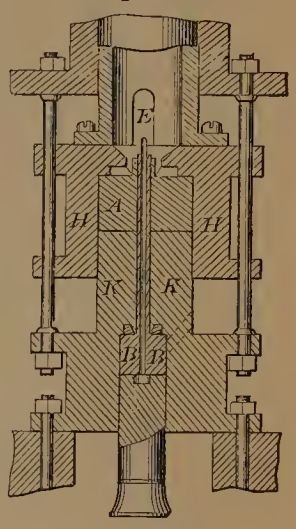
In Fig 6463, the tin is cast around the mandrel *e*, and is protected by a tube from the heated lead when the latter is poured into the cylinder *a a*. By a motion of the plunger *b b* or cylinder *a a*, either of which may be the working part, the two metals are forced through a die at the bottom of the cylinder and united together.

**Tin-liq'uor.** A dyer's solution of tin, digested in hydrochloric and nitric acids, with an addition of salt.

**Tin'man's-punch.** A punch or swage for sheet-metal workers' use. The plunger in the machine illustrated is worked by treadle. See also PUNCH; SHEET-METAL; STAMPING-MACHINE.

**Tin'man's-shears.** Hand-shears from 4 to 9 inches in length; the ends of the handles are bent toward each other, so as to meet when closed; also known as *snips*. The bench-shears are 18 inches or more in length, and one handle is bent down, forming a square tang, which is inserted through a hole in the bench; the other operates the movable blade. See SHEARS, Figs. 4928, 4929.

Fig. 6462.




*Machine for Making Tin-Lined Lead-Pipe.*

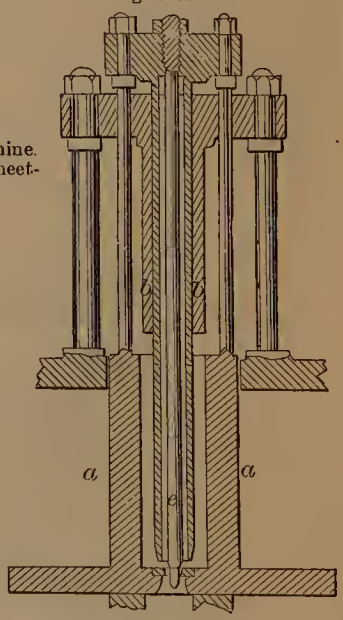
**Tin'man's-sol'der.** Ordinary or fine tin solder is composed of 2 tin, 1 lead, and melts at about 360° Fah.

Plumbers' solder consists of 1 tin, 3 lead, melting at about 500° Fah. See SOLDER; ALLOYS.

**Tin'man's Tools.** See under the following heads: —

Anvil.
Autogeneous soldering.
Bat.
Beak-iron.
Copper bit.
Creasing-tool.
Die.
Double-seaming tool.
Flanging and wiring machine.
Grooving-machine for sheet-metal.
Grozing-iron.
Latterkin.
Mallet.
Planishing-hammer.
Punch.
Raising-hammer.
Riveting-hammer.
Riveting-set.
Roof-seaming machine.
Seaming-machine.
Seaming-tools.
Seam-set.
Setting-punch.
Shears.
Sheet-metal folder.
Sheet-metal press.
Sheet-metal shears.
Snarling-iron.
Snip.
Solder.
Soldering-furnace.
Soldering-machine.
Soldering-tools.
Spinning-metal.
Stake.
Stamping-machine.
Striking-up press.
Swage.
Swaging-machine.
Teest.
Tinner's folding-machine.
Tinner's stove.

Fig. 6463.




*Tin-Lined Lead-Pipe Machine.*

**Tin'ner's Fold'ing-ma-chine'.** One in which the sheet-metal, cut to the required shape and size, is laid upon the bed-piece, held by a lever, and bent up against the *former* by a folder. The sides of the pan are operated upon consecutively.

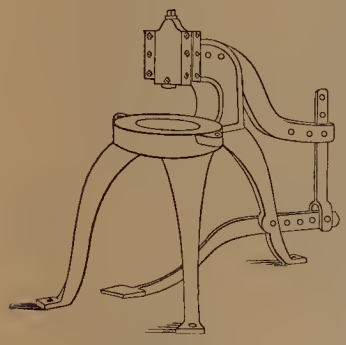
**Tin'ner's Stove.** A sheet-metal stove used by tinmen for heating the soldering-tools. See Figs. 5293, 5294.

**Tin'ning.** The art of coating other metals with tin.

The Romans employed tin (*stannum*) for lining vessels of copper in which were cooked articles which would corrode the copper. The practice is cited by Pliny, Columella, Palladius, and others. Silver was previously used for this purpose, and afterward a pewter (*argentarium*), lead and tin. The tinned

vessels were known as *vasa stannea*. The pure tin was preferred, and the mixture of lead considered an adulteration, as we understand the passage of Pliny. Galen refers to the same mode and kind of adulteration.

Fig. 6464.



*Tinman's Punch.*

The process seems to have been by immersion, as at present practiced.

Hollow ware is tinned inside, having been first thoroughly cleaned and heated, by pouring grain tin into the vessel and turning and rolling it about so as to bring it in contact with every part. Powdered rosin is used in the bath to prevent the formation of an oxide, and the surface of the ware is rubbed with cloth or tow to aid the process. In *cold tinning* an amalgam of tin and mercury is applied to the metal, the mercury being afterward driven off.

Bridle-bits, stirrups, and other small articles are tinned by immersion.

See also the following: —

By simple immersion. Dissolve 17¼ ounces ammonial alum in 12 pounds boiling water, and when dissolved add 1 ounce protochloride of tin. The articles to be coated are well cleaned, and then immersed in this liquid until they are sufficiently white. The ammoniacal salts last a long time, but the tin salt requires occasional renewal.

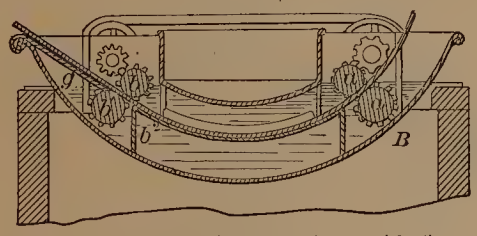
By contact with another metal in a suitable liquid. Dissolve 10½ ounces bitartrate of potassa in 17½ parts water, and add ¾ ounce protochloride of tin, and boil it a few minutes. The articles to be coated are immersed in a solution, in contact with a piece of zinc of proportionate size.

By the battery. Dissolve 11 ounces pyrophosphate of potassa or soda in 17½ pounds water, and then add 4½ ounces protochloride of tin, and operate by the battery process with an anode of tin. See also TIN-PLATE.

Wegler gives the following method: —

A solution of perchloride of tin is first prepared by passing washed chlorine gas into a concentrated aqueous solution of tin salt, and expelling the excess of chlorine by gently warming it, then diluting it with eight to ten times its volume of water, and filtering it, if necessary. The article, well pickled in dilute sulphuric acid, and polished with sand and a steel scratch-brush, and rinsed with water, is loosely wound with a zinc wire, and immersed for ten or fifteen minutes, at the ordinary temperature, in the dilute solution of perchloride of tin. When tinned in this way, it is raised, brushed with a scratch-brush, dried, and finally polished with whitening. This applies to tinning cast-iron, wrought-iron, steel, copper, brass, lead, and zinc.

Fig. 6465.




*Apparatus for Coating Metal Plates with Tin.*

In Butterworth's apparatus (Fig 6465), the sheet of metal to be tinned is drawn through the bath contained in the melting-pan *B*, being fed down the guide-plate *g* and drawn forward by the rollers *b b*¹ *a a*. A curved apron $b^2$ supports the sheet while passing through the bath.

The following is M. Heeren's process for giving iron wire the appearance of silver by a thin film of tin: the iron wire is first placed in hydrochloric acid, in which is suspended a piece of zinc. It is afterward placed in contact with a strip of zinc in a bath of two parts tartaric acid dissolved in 100 parts of water, to which are added three parts of tin salt and three parts of soda. The wire should remain about two hours in this bath, and then be removed, and made bright by polishing, or drawing through a polishing-iron. By this galvanic method of tinning, wire which has been wound in a spiral, or iron of other shape, can be made quite white, which is an advantage over most other methods, where the wire is tinned in the fire and then drawn through a drawing-plate.

**Tin-plate.** Iron-plate coated with tin by dipping it into a molten bath of the latter metal.

The art of tinning plate-iron seems to have been invented in Bohemia, was carried from thence into Saxony, 1620, and other parts of Germany, whence the rest of Europe was supplied until near the end of the seventeenth century. The art was introduced into England by Yarranton about 1675.

The iron used is *charcoal iron*, rolled into sheets of various thickness, according to the grade and size of the plates, which are cut into rectangular pieces of the required sizes.

The processes are as follows: —

*Scaling.* The plate is bent so as to enable it to stand when placed on edge, and is then pickled in a trough containing dilute hydrochloric acid. The bent plates being laid on the floor in a row, a rod is placed under them, and they are thus lifted and placed in a furnace, where they are heated to redness. The scale then drops off; after removal and cooling, the plate is beaten smooth on a cast-iron anvil. Cold rolling between hard, polished rollers confers smoothness and elasticity.

*Pickling.* The plates are immersed in a bath of acidulated bran-water, at about 100° Fah., for 12 hours, standing half the time on one edge and half on the opposite one. They are then transferred to a bath of dilute sulphuric acid (100° Fah.), which makes them bright. This is followed by a bath of clean water and scouring with hemp and sand.

*Tinning.* The series of pots in which the dipping is performed is placed in a brick structure which rises above the floor of the factory, and at which the workmen stand. This structure is called the *stow*, and contains the furnace which heats the pots. These cast-iron pots are arranged in a row, and are five in number, — the *tin-pot*, *wash-pot*, *grease-pot*, *pan*, and *list-pot*.

The *tin-pot* contains about 500 pounds of block and grain tin, on which floats 4 inches of tallow, to prevent oxidation. Alongside it is a grease-pot.

The *wash-pot* is nearly full of the best grain-tin, and has a partition to prevent the dross from gathering at that part where the last dip is given to the plates.

The *grease-pot* contains lard or tallow free from salt.

The *pan* has a grating at bottom, and no fire *under* it.

The *list-pot* has only ¼ inch depth of tin in it.

The operation is as follows: —

300 plates previously dipped in a grease-pot are placed one by one in the *tin-pot* (No. 1), in a vertical position, and left for an hour or two, the heat being as great as possible without burning the grease. They are then taken out by tongs and placed on an iron rack to drain.

The plates are then placed in the larger division of the *wash-pot* (No. 2), which melts off the superfluous tin acquired in No. 1; being taken out, a few at a time, from No. 2, they are taken up singly by a pair of tongs, swept on each side by a hempen brush, to make the layer equable and remove drip, and receive a final dip in the clean side of the *wash-pot*, by which the marks of the brush are erased.

Each plate, after its final dip in metallic bath, is plunged in the *grease-pot* (No. 3), which is so hot as to remove superfluous metal, allowing it to drain off and collect in the bottom of the pot. The plates stand singly in the grease-pot, being separated by pins, and as the pot holds but five, a boy is continually removing the one which has been longest in the grease.

As the boy takes the plates from the *grease-pot* (No. 3), he places them on edge in the cold pans (No. 4) to drain off the grease and cool

The *list-pot* (No 5) is employed for melting off the *list* or selvage of tin which has accumulated at the edge of each plate as it stood vertically in the *wash-pot* and *grease-pot* (Nos. 2 and 3). The *list*, being thus melted, is detached by a smart tap with a stick.

The grease is cleaned from the warm plates by rubbing with dry bran. The plates are then boxed. Trade custom has prescribed the grades, weights, and sizes, which are indicated by certain marks on the boxes, as shown in the following table: —

| Names. | Sizes. | No. in a Box. | Weight in a Box. | Box-Marks. |
|---|---|---|---|---|
| | Inches. | | Pounds. | |
| Common, No. 1 | 13¾×10 | 225 | 112 | CI |
| Common, No. 2 | 13¼× 9¼ | 225 | 105 | CII |
| Common, No. 3 | 12¾× 9½ | 225 | 100 | CIII |
| Cross, No. 1 | 13¼×10 | 225 | 140 | XI |
| Two cross, No. 1 | 13¼×10 | 225 | 161 | XXI |
| Three cross, No. 1 | 13¼×10 | 225 | 182 | XXXI |
| Four cross, No. 1 | 13¼×10 | 225 | 203 | XXXXI |
| Common doubles | 16¾×12¼ | 100 | 77 | CD |
| Cross doubles | 16¾×12¼ | 100 | 126 | XD |
| Two-cross doubles | 16¾×12¼ | 100 | 147 | XXD |
| Three-cross doubles | 16¾×12¼ | 100 | 168 | XXXD |
| Four-cross doubles | 16¾×12¼ | 100 | 189 | XXXXD |
| Common small doubles | 15 ×11 | 200 | 168 | CSD |
| Cross small doubles | 15 ×11 | 200 | 189 | XSD |
| Two-cross doubles | 15 ×11 | 200 | 210 | XXSD |
| Three-cross doubles | 15 ×11 | 200 | 231 | XXXSD |
| Four-cross doubles | 15 ×11 | 200 | 252 | XXXXSD |
| Wasters, common, No. 1 | 13¾×10 | 225 | 112 | WCI |
| Wasters, cross, No. 1 | 13¾×10 | 225 | 140 | WXI |

The process in Pittsburg is as follows: —

The sheets, cut into the desired sizes, are "pickled" by immersion in a bath of dilute sulphuric acid for 10 to 20 minutes. They are then annealed for from 6 to 7 hours; then rolled cold, to give them a surface polish. This operation hardens the iron, so that the plates are again annealed, with greater care and at a lower temperature, for 6 or 7 hours. The plates are then again pickled in an acid bath for some 10 minutes, to remove the scale of oxide, washed in water to remove the acid, and then plunged for a few moments into a bath of palm-oil or melted tallow. The plates are then put, 40 or 50 at a time, in a tin bath, where they remain about 15 minutes. On leaving this, the plates are plunged into a second tin bath, on leaving which they have the dross brushed off, and go to the third tin bath; from that they go into a tallow or oil bath, from which they are drawn by passing between rolls, which smooths them. They are then rubbed with shorts, or bran and leather, to clean them, sorted and boxed, each box of I. C. plate, containing 112 pounds, or 112 plates, the plates having a gage of about No. 30, and weighing one pound each; I. X. brand weighs 140 pounds to the 112 sheets.

**Tin-pot.** The first of the set of baths in which sheet-iron is dipped for tinning.

It is a rectangular cast-iron vessel holding about 500 pounds of block and grain tin, and heated by a furnace, which envelops the sides and bottom. The molten tin is covered with a layer of tallow four inches thick, to prevent oxidation.

The other baths or pans are the *wash-pot*, *grease-pot*, *pan*, and *list-pot*. See TIN-PLATE.

**Tin-saw.** (*Bricklaying.*) A saw used by bricklayers for cutting kerfs in bricks in order to render them more readily dressed by the axe which hews them into shape for the skew or gaged work, dome, or niche for which they are destined.

**Tin-scrap.** Clippings or scraps made in the manufacture of tin-ware. It consists of iron plate, partially alloyed, and also coated, with tin, the amount of the latter varying from three to five per cent. In inferior wares the tin is itself debased with lead.

In the manufacture of tin-ware it is said that 6 per cent of the whole of the plates employed disappears in the form of scraps. The trade in sardine-boxes produced at Nantes, in 1869, nearly 400 tons of scrap; Birmingham produces about 20 tons per week, and Paris 50 to 60 tons per month. The tin-scrap of New York is estimated at 30 tons per day. A small quantity of these scraps has always been used in various ways, such as fluxing lead ores, and the addition of a small proportion to the pig-iron intended for steam-cylinders.

The following plans for the recovery of the tin have been proposed: —

*a.* Edward Schunk (English) patented, in 1848, three processes: the first involving the use of sulphide of sodium; the second, of soda, lye, and litharge; and the third, of a solution of chromate of potash and caustic soda. He preferred the first, as most perfectly liberating the tin, and for other reasons. The alkaline process is said not to extract the tin completely.

*b.* James Higgin, in 1854, patented a treatment of the scraps with muriatic acid and water, mixed with a substance, such as nitrate of soda, to liberate chlorine, and facilitate the solution, from which the tin was subsequently precipitated with powdered chalk; ammonia is stated to be obtained as a by-product.

*c.* Charles Frederick Claus patented in 1859 the use of a solution of sulphide of calcium, containing sulphur in excess. He recommended alkali waste and gas waste. From the solution hisulphide of tin is precipitated by means of muriatic acid, and converted to oxide, and finally to metallic tin.

*d.* Alexander Parkes, in the same year, employed mercury, forming a tin amalgam, which was subsequently retorted. The use of mercury is prejudicial to health.

*e.* The same person, in 1858, recommended concentrated oil of vitriol.

*f.* J. M. Patterson, of New Jersey, patented, in 1863, the use of a bath of melted lead, to form an alloy with the tin, which, suitable proportions of tin being added, may be used as solder.

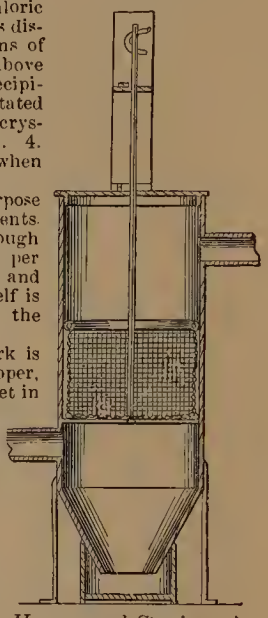
*g.* Mr. Everett, of New York, in 1865, proposed to use tin-scraps in smelting galena.

*h.* Sturdevant and Harmon, New York, propose to melt off the tin from the scraps by means of hot air and steam in a cylindrical retort with a perforated, inverted conical bottom.

*i.* Ott's method consists in the solution of the tin and lead of the scraps in muriatic, with a slight admixture of nitric acid, the precipitation of the lead from this solution by means of sulphuric acid, and the final precipitation of the metallic tin by means of spelter. The iron scraps are washed first in water, then in a weak alkaline solution, then again in water, after which they are barreled and sent to the puddling-furnaces.

The subject has been treated by M. Knenzel in the "Bergund Uttannannische Zeitung." The mode employed by him comprises four chief operations: 1. Treatment of the scraps by means of boiling in water acidulated with hydrochloric and nitric acid, until all the tin is dissolved. 2. Precipitation by means of zinc of the tin contained in the above solution and washing of the precipitate. 3. Solution of the precipitated solution in hydrochloric acid, and crystallization of the chloride of tin. 4. Utilization of the iron scraps when despoiled of the tin.

Fig. 6466.



*Harmon and Sturdevant's Apparatus for Removing Tin from Sheet-Metal.*

Most inventions for this purpose have failed in one of the requirements. Either the iron is not left pure enough to be marketable (less than one per cent of tin makes it cold-short and worthless), or the tin-product itself is not in salable form, or, finally, the process is not cheap.

A process pursued in New York is about as follows: A cylinder of copper, glass lined, is provided, some 6 feet in diameter and 5 feet long, capable of holding 1,000 pounds of the scrap. This is arranged upon a shaft so that it can be revolved in a glass-lined tank filled almost to the brim with hydrochloric acid. When the acid has dissolved the tin, the cylinder is lifted out of the tank and lowered into a cistern of water, where it is revolved a few minutes and then transferred to a second tank of water, and turned a few times to wash away all the acid; after this it is rotated for a little while in a fourth tank, containing a weak solution of silicate of soda, to remove traces of acid and prevent the iron from rusting. The tin is dissolved in the first tank of acid, which soon becomes saturated. It is now drawn off into another tank, and the tin is separated by putting in zinc, for which the acid has a greater affinity than for tin. The chloride of zinc thus formed is useful for other purposes, and the tin remains pure. The whole time thus required to treat a charge is but little over an hour.

**Tin'sel.** 1. A shining thin metallic plate. *Foil.* Somewhat allied to tinsel is the *metallic dust*, the invention of John Hautsch, of Nuremberg, 1595–1670.

2. (*Fabric.*) A cloth composed of silk and silver. A material with a superficial sheen and but little sterling value.

Cloth overlaid with foil.

**Tin-tack.** A tack dipped in melted tin.

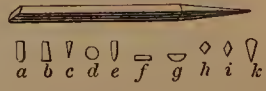
**Tint'ed Pa'per.** Paper with moderate depth of color.

Tints are grades of color, and are made by the addition of white pigment to all color, or of water to a water color, subduing the energy of the color.

**Tin'tin-nab'u-lum.** A musical instrument of percussion, consisting of a number of bells suspended in a frame.

**Tint-tool.** (*Engraving.*) A graver for cutting the lines employed in forming tints. They are of various sizes, according to the character of the work and the depth of tint to be produced.

Fig 6467.

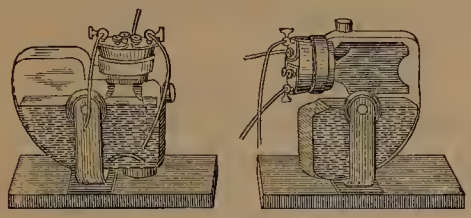



*Gravers' and Tint Tools.*

*a*, round-edge graver.
*b*, square-edge graver.
*c*, knife-edge graver.
*d*, round graver.
*e*, graver.
*f*, flat graver.
*g*, half round graver.
*h*, square graver.
*i*, lozenge-graver.
*k*, tint-tool.

**Tip.** 1. (*Gilding.*) A tool made of camel's hair, and used by the gilder in transferring gold-leaf from the *cushion* to the sized surface of the work. The ends of a number of camel's hairs are secured by their buts between two cards, which are glued together, thus making a broad, flat, and very elastic brush. This is laid upon a piece of gold-leaf, which adheres to it slightly, and is thereby removed. See GILDING.

Fig. 6468.

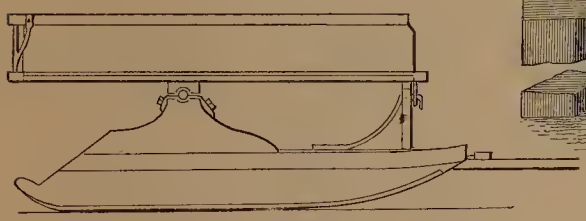


*Tip-Battery.*

2. (*Hat-making.*) A circular piece of scale or paste board pasted on the inside of a hat crown to stiffen it.

3. (*Shoemaking.*) A protecting cap at the toe end of a shoe.

Fig. 6469.



*Tip-Sled.*

4. The nozzle of a gas-burner.

5. A ferrule ; as the tip of a bayonet scabbard.

6. The rubbish of a quarry.

**Tip-bat'ter-y.** (*Electro-Magnetism.*) A battery in which the vessel turns on a horizontal pivot, so that the pairs of plates may be immersed in or raised clear of the liquid in the trough by tilting.

**Tip-pa'per.** A variety of paper of a rigid quality, made for lining the *tips* or insides of hat-crowns.

**Tip'pet.** 1. (*Wear.*) A fur or cloth covering for the neck and shoulders, worn over the dress.

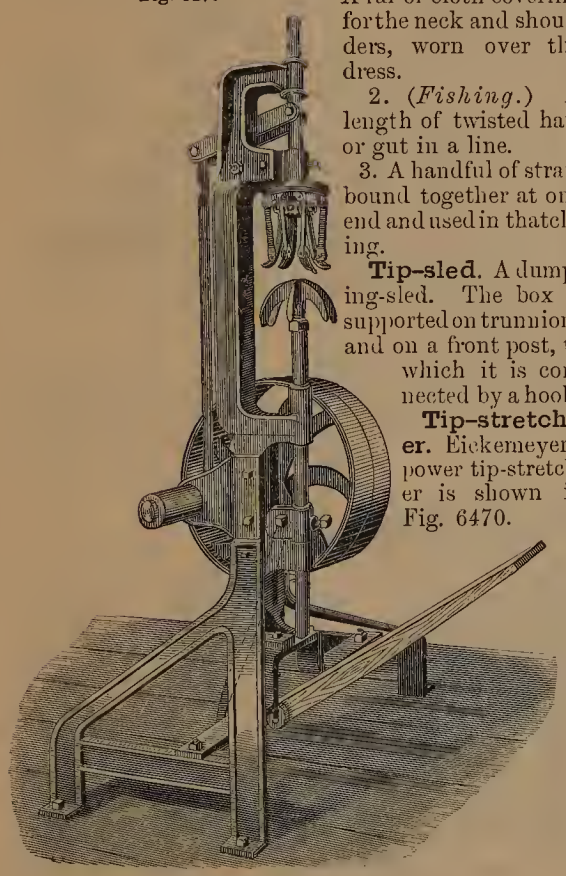
2. (*Fishing.*) A length of twisted hair or gut in a line.

3. A handful of straw bound together at one end and used in thatching.

**Tip-sled.** A dumping-sled. The box is supported on trunnions and on a front post, to which it is connected by a hook.

**Tip-stretch'er.** Eickemeyer's power tip-stretcher is shown in Fig. 6470.

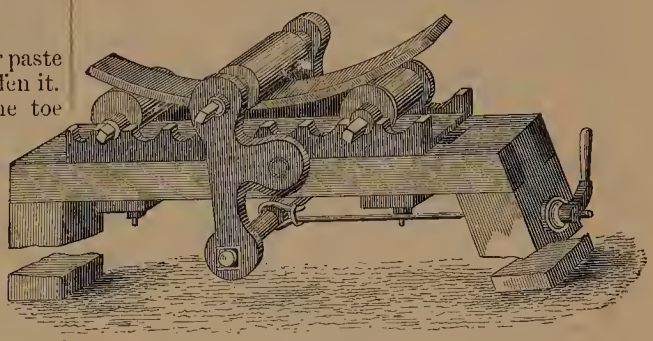
Fig. 6470.



*Eickemeyer's Tip-Stretcher.*

The *star* upon which the hat-body is placed is connected with the treadle, and is raised up when the treadle is depressed. This star is screwed upon the sliding spindle, and may be exchanged for another star of a different size. Above the star are the adjustable *stretching-fingers*, which can be set by a hand-wheel to stretch the hat-body more or less. The stretching-fingers are attached to another sliding spindle, which is caused to move up and down in rapid succession by the walking-beam on the upper end of the frame, which receives its motion from a crank on the short shaft of the machine. A loose and tight pulley on the same shaft are driven from any suitable pulley, and give motion to the reciprocating stretching-fingers.

Fig 6471.



*Tire-Bender.*

The hat-body is kept as hot as steam will make it, and placed upon the star while the machine is in motion, and by the depression of the treadle is brought up in contact with the stretching-fingers. Every time these fingers come down the hat-body is stretched a certain amount ; and as the fingers retreat, the body is slightly turned on the star by the operator, who pushes the hat-body up and turns it a little every time the fingers leave it, and the hat is stretched from 100 to 120 times a minute.

**Tire.** 1. (*Vehicle.*) An iron band around the fellies of a wheel.

The circular continuous tire is of American origin. In Europe tires were, until lately, generally made in sections arranged to break joint with the fellies.

The rim-tire is expanded by heating, and then shrunk on so as to tightly compress the wheel, and bolted ; in the sectional tire, bolts only are relied on to hold the parts together. Steel railway-tires are always of the former kind.

Theocritus, the Greek poet, describes the chariot-maker bending a slat rived from the limb of a wild fig-tree and rendered pliable by roasting in the fire, "in order to form the circumference of a wheel." The same agent, fire, was used in early times to supple the planks of vessels. See WOOD-BENDING.

India-rubber wheel-tires are used for the purpose of decreasing the jar on the vehicle, and as a means of increasing the tractive adherence.

In the Thomson road steamer a thick rubber tire, capable of yielding to the inequalities of the ground, and protected by an endless band of steel slats, is employed.

In 1852, a patent was granted to Marcus Davis in England, for forming locomotive tires of a soft material, covered with india-rubber protected by an exterior sheet of steel. In the same year Thomas Allan obtained a patent for encircling wheels with an outer tire of vulcanized india-rubber, solid or tubular, or other elastic substance. The advantages of this arrangement for road locomotives were particularly set forth. At the same time Mr. Dunlop patented a tire of annealed cast-iron, grooved to receive an india-rubber band. Various other patents followed, embracing india-rubber as a material to be used in constructing tires.

A source of trouble with continuous tires on wooden wheels is the shrinkage of the timber particularly when green, rendering cutting and resetting the tires necessary. To obviate this it is recommended to use only seasoned timbers for the fellies, and soak them in boiling linseed-oil. See also TIRE-BENDER ; TIRE-SHRINKER.

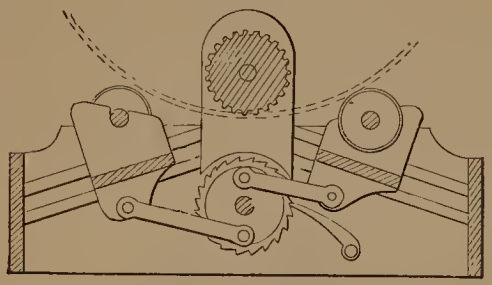
2. (*Railway.*) The rim of a driving-wheel, shrunk on to the other portion.

**Tire'balle.** (*Surgical.*) The bullet-forceps.

**Tire-bend'er.** A device for bending tires to a uniform circular curve.

That illustrated (Fig. 6471) has two lower rollers, which may be placed at various distances apart, in a bed-plate having semicircular grooves to receive their journals, and an upper roller journaled in a swing-frame, adjustable by a screw-thread-

Fig. 6472.

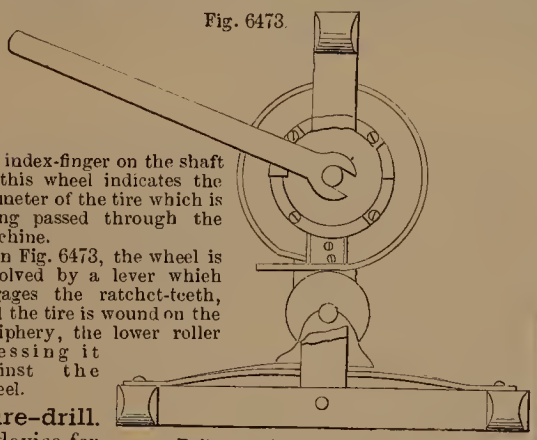


*Gettemy's Tire-Bending and Shrinking Machine.*

ed strap-rod. The rollers are adjusted to the curve of the particular tire to be formed, and are turned by levers or cranks, drawing the bar of metal between them.

In Fig 6472, the journal-blocks of the end rollers slide in inclined guides, being actuated by liuks connecting them to crank-pins on the central ratehet-wheel, which is turned by a lever.

Fig. 6473.



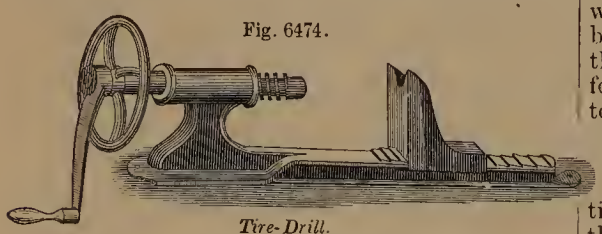
*Ballou's Tire-Bending Machine.*

An index-finger on the shaft of this wheel indicates the diameter of the tire which is being passed through the machine.

In Fig. 6473, the wheel is revolved by a lever which engages the ratchet-teeth, and the tire is wound on the periphery, the lower roller pressing it against the wheel.

**Tire-drill.** A device for drilling the bolt-holes in tires. It is secured to the bench, and has a ratchet-clamp for holding one side of the tire, the other being passed over a suitable post or stud. The drill-holder has a screw-thread on its periphery, works in a box, and is advanced by turning a crank.

Fig. 6474.



*Tire-Drill.*

**Tire'fond.** (*Surgical.*) An instrument used to elevate the piece of bone sawed off by the trephine.

**Tire-heat'er.** A furnace in which a tire is expanded by heat so as to tightly embrace the circle of fellies, or the rim of the wheel on which it shrinks in cooling.

In Fig 6476, the tires are laid horizontally in an annular fire-space, and a cover containing escape-flues may be let down upon it to preserve the workmen from the heat and carry off the smoke.

In Fig. 6477, the tires are placed upon edge in the annular case, which is turned upon rollers above the fire.

**Tire-meas'ur-er.** An instrument for measuring the circumference of wheels and the length of the developed tires, invented by Wray of Springfield, Ohio, are shown in Fig. 6478. It differs from the ordinary tire-circle in having a supplementary hand *b* attached to the pointer *a*, which is fixed, while the hand *b*

Fig. 6475.

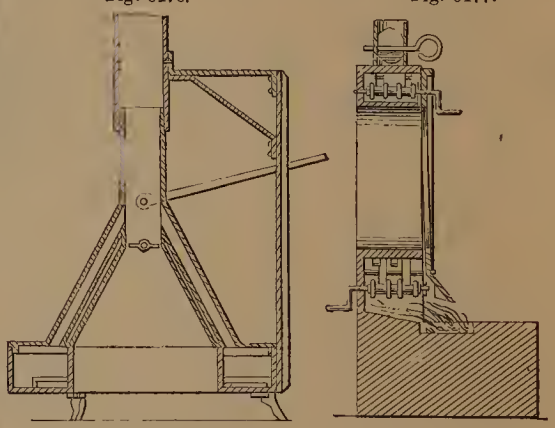
*Tirefond.*

may be set so as to allow for the desired lap in welding.

**Tire-press.** A machine for driving the wrought-iron or steel tire on to the rim of a driving-wheel.

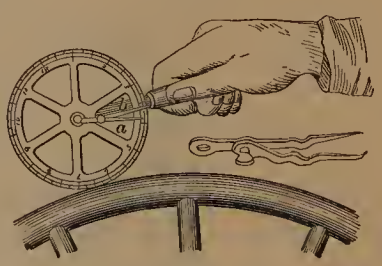
Fig. 6479 shows an application of the hydraulic press to this purpose. The tire is turned to a tight fit; the bars *a a* are fitted with slots or openings, that they may be brought nearer or put farther from the center, and the pieces *b b b b* can be changed for the larger wheels. There is an opening in the plate *c* to admit the axle, and by short temporary rails the wheels can be rolled into position.

Fig. 6476. Fig. 6477.



*Stroud's Tire-Heater.* *Pierce's Tire-Heater.*

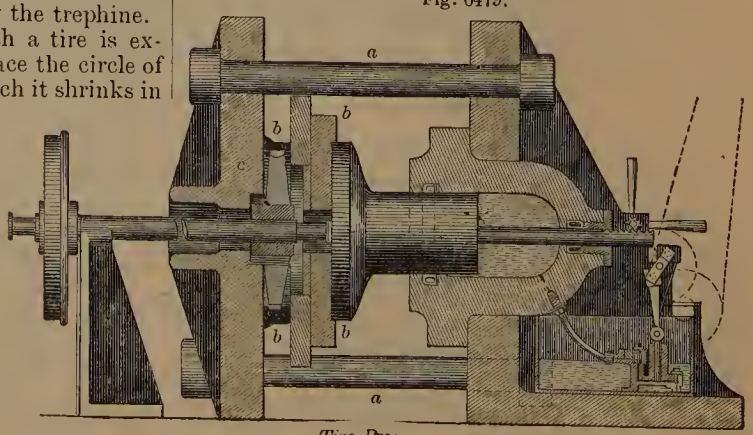
Fig. 6478.



*Tire-Measurer.*

**Tire-roll'er.** A form of rolling-mill for tires in which the rolls between which the work is performed are made to overhang their bearings and be movable from or to each other, so as to allow the endless tire to be introduced between them and the parts then brought together, so that the *pass* is complete.

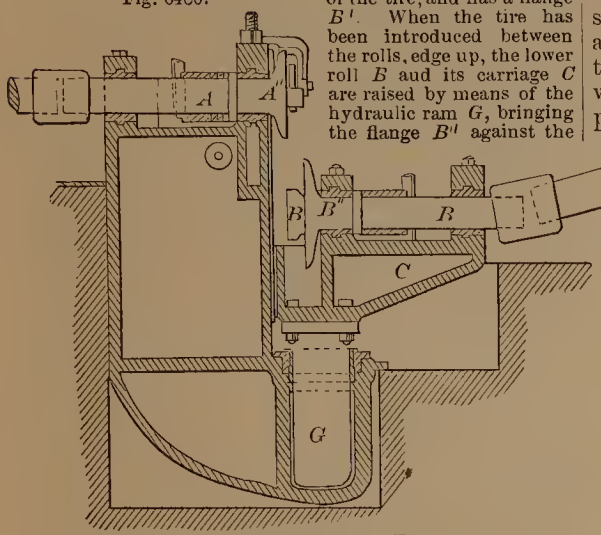
Fig. 6479.




*Tire-Press.*

The parts are shown open in the figure. *A* is the roll to operate on the inner side of the tire, and has a flange *A''*. *B* is the roll to operate on the outside of the tire, and has a flange *B'*. When the tire has been introduced between the rolls, edge up, the lower roll *B* and its carriage *C* are raised by means of the hydraulic ram *G*, bringing the flange *B''* against the

Fig. 6480.



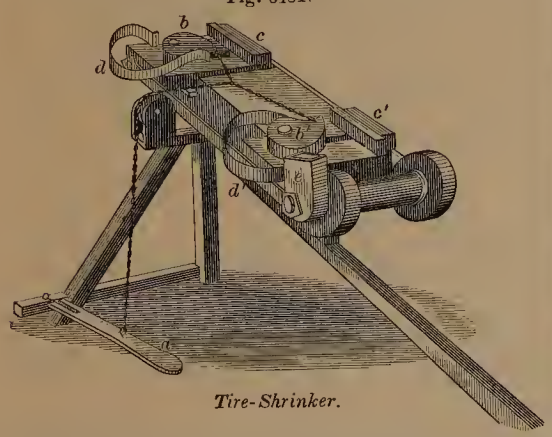

*Vickers's Mill for Rolling Railway-Tires.*

end of the roll, and the flange *A'* against the end of the roll *B*, confining the tire, and bringing the required pressure to bear upon it.

**Tire-shrink'er.** A device for shortening tires when they have become loose from the shrinkage of the wheel.

By depressing the treadle *a*, the cams *b b'* are drawn away from the blocks *c c'*; the heated part of the tire is then inserted,

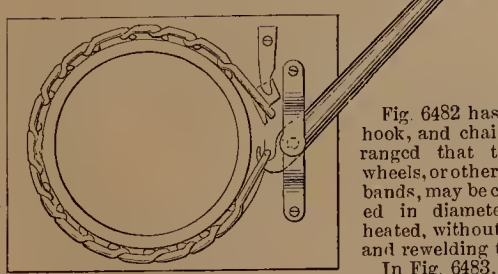
Fig. 6481.




*Tire-Shrinker.*

and the treadle released. when the springs *d d'* act to throw out the cams clamping the tire between them and the blocks. By depressing a lever, inserted in the socket *e*, the two ends of the table are caused to approach each other, thus condensing the heated portion of the tire.

Fig. 6482.



*Weitman's Tire-Shrinker.*

Fig. 6482 has a lever, hook, and chain so arranged that tires for wheels, or other metallic bands, may be contracted in diameter while heated, without cutting and rewelding them.

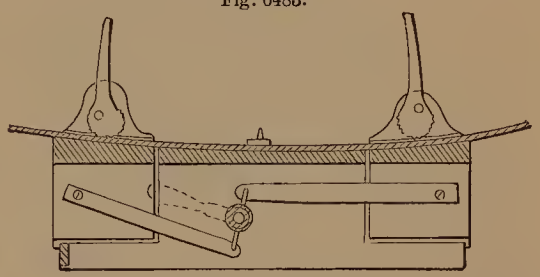
In Fig. 6483, the tire is clamped to the moving end blocks of the frame by corrugated cams, with its convex side resting upon the curved central plate. The end blocks are then approached, to reduce the tire in length.

**Tire-tete.** (*Surgical.*) An instrument for extracting the head of the fetus. A *crochet.*

**Tire-up-set'ting Ma-chine'.** A machine for shrinking tires without cutting. The tire is heated and then forcibly compressed endwise, so as to thicken it in one part and shorten it. It is then, while yet hot, placed on the wheel and shrunk in position.

Fig 6484 is a machine for *upsetting*, *cutting*, and punching tires. The upper figure shows the upsetter; the heater tire is placed between the clamps, one of which is on a sliding head; as the heads are brought together the tire is shortened. The shears and puuch are shown beneath, being operated by an oscillating cam, moved by rack, pinion, and lever.

Fig. 6483.



*Jackson's Tire-Shrinker.*

**T-ir'on.** A kind of angle-iron having a flat flange and a web like the letter T, by which it is called. See ANGLE-IRON.

**Ti'sar.** (*Glass.*) The fireplace at the side of and heating the *earquaise* or annealing arch of the plate-glass manufacture.

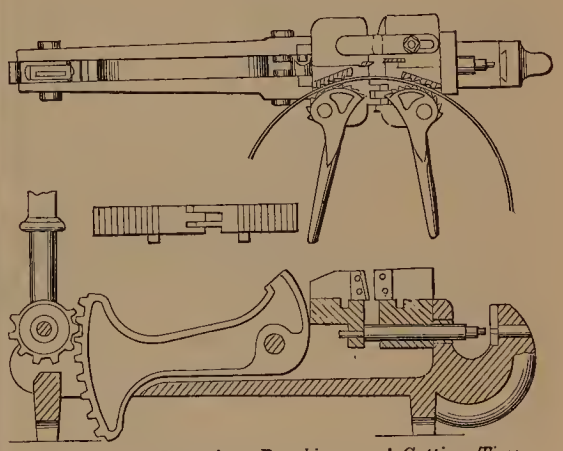
**Tis'sue.** (*Fabric.*) *a.* A very fine transparent silk stuff used for veils; white or colored.

It was formerly interwoven with gold or silver threads and embossed with figures.

"In their glittering *tissues* bear imblazed
Holy memorials." — MILTON.

"A robe of *tissue* stiff with golden wire." — DRYDEN.

Fig. 6484.



*Machine for Upsetting, Punching, and Cutting Tires.*

*b.* Cloth interwoven with gold.

**Tis'sue-pa'per.** A very thin gauze-like paper made of several sizes, and used for the protection of engravings, for wrapping fine and delicate articles.

*Tracing* paper is a good grade of tissue, rendered more transparent by treatment with oil or varnish.

**Ti-ta'ni-um.** Equivalent, 25; symbol, Ti.; fusible under the blow-pipe. Has a deep blue color, and is used in coloring porcelains and enamels. Discovered by Gregor in 1791. Its ore is called *menachanite*, from Menachan, in Cornwall, where it was first found.

**Ti'tho-nom'e-ter.** An instrument for noting the *tithonic* or chemical effect of the rays of light. See ACTINOMETER.

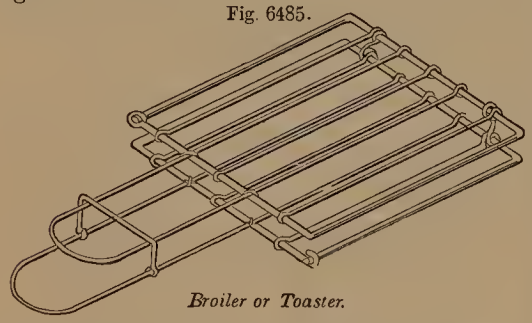
**Ti-thon'o-type.** (*Photography.*) A process in which a cast is obtained from an original phototype-plate.

**Ti'tle.** 1. (*Bookbinding.*) The panel between bands, used for the book's name.

2. (*Printing.*) *a.* The name of a book on the first page.

*b.* The *running-title* is at the head of a page, and consists of the name of the book or the subject of the page.

Fig. 6485.



*Broiler or Toaster.*

**T-joint.** The union of one pipe or plate rectangularly with another, resembling the letter **T**.

**Toast'er.** A fork or cage to bread or meat while toasting. Fig. 6485 is a toaster or broiler.

**Toast'ing-fork.** A three or four pronged fork to hold a slice of bread while toasting.

**Toast-rack.** A small rack of wire to hold toast on edge on the table.

**Toat.** The handle of a bench-plane.

**To-bac'co.** A plant indigenous to America, and used in various forms, — smoking, chewing, snuffing, — from the northwest coast to Patagonia.

The name is probably derived from *tabaco*, a forked tube through which the fumes were inhaled into the nostrils. The island of Tobago is said to have been so named by Colon from a supposed resemblance to this shape, — "Y." The Caribs are said to have called it *kohiba*. Roger Pane, the friar who accompanied Christopher Colon in his second voyage, gives it as *cogiaba*, its Hispaniolan name, otherwise spelt *cohiba*. It was known as *petun* in Brazil; *piecell* in Mexico, or, according to other authorities, *yetl*; *yoli* in other places.

All the present modes of using the tobacco plant originated in America.

*a.* Columbus noticed that the natives of the West India islands used the leaves in rolls, — cigars. The Aztecs had cigar tubes, and also used nostril tubes of tortoise-shell for inhaling the smoke. The Mexicans and North American Indians used pipes.

Oviedo speaks in 1526 of the inhaling of the smoke through the forked nostril tube by the Indians of Hispaniola.

Lobel, in his "History of Plants," 1576, gives an engraving of a rolled tube of tobacco (a cigar) as seen by Colon in the mouths of the natives of San Salvador. He describes it as a funnel of palm-leaf with a filling of tobacco leaves. The pipe is shown in the engravings to De Bry, "Historia Braziliana," 1590.

*b.* Cortez found smoking the pipe to be an established custom in Mexico. Bernal Diaz relates that Montezuma had his pipe brought in great state by the ladies of his court after he had dined, and washed his mouth with scented water.

In the city of Mexico, tobacco-pipes of various forms and grotesque shapes are dug up from time to time.

"The mound-builders were inveterate smokers." — SQUIER; DAVIS.

*c.* When the Spaniards landed in Paraguay, in 1503, the chewing natives "spurted the juice toward them."

Pizarro found tobacco-chewers in Peru.

Masticatories were used anciently in Europe. Plutarch says that the chewing of mallows is very wholesome, and the stalk of asphodel very luscious. See also TEA.

*d.* Snuffing was practiced by the Aztecs and by the Brazilians. See Brazilian snuff-mill, Fig 5262, page 2232.

Roger Pane, in 1494, speaks of the inhalation of snuff through tubes.

The principal tobacco of commerce is derived from the *Nicotiana tabacum*, the American plant; the *Nicotiana persica*, or Persian tobacco, and *N. rustica*, or Syrian, are used in Europe and Asia. It is also grown in Africa, and the native name indicates that it is of the common stock. The genus *Nicotiana* belongs to the *Solanaceæ*, which includes the nightshade, potato, and tomato. The name *Nicotiana* is derived from Jean Nicot, the minister of France in Portugal, 1660, who first made the plant known in France.

It has been conjectured that the Asiatic variety is derived from China, which has been regarded as another center of production. The probabilities are against the supposition.

It was introduced into England by Sir John Hawkins in 1565, and by Sir Walter Raleigh and Sir Francis Drake in 1586. The practice was made the butt of the wits, the object of denunciation by the clergy, and the subject of a pamphlet by the silly King James I., who published his "Counterblaste to Tobacco." Its use was condemned by kings, popes, and sultans, and smokers were condemned to various cruel punishments.

The manufacture of tobacco depends upon the kind of tobacco and the article required. Cigars are made of the best, which is grown on soils peculiarly adapted to produce the delicate flavor; a portion of the northwest of the island of Cuba is the best of all. The Connecticut Valley, some parts of Virginia, a few counties in Ohio and Kentucky, near Cincinnati and Maysville, respectively, are noted regions. Of the foreign regions we are not well informed. The *Manilla* and *Hungarian* are noted. Tobacco is packed in hogsheads for sale and shipment, and the different processes commence when it reaches the factory.

Chewing-tobacco is put up in ropes, plugs, knots, and various other forms. The shapes and flavors are matters of taste, and the latter becomes a fashion; comparatively little of the leaf is used in its natural state. Plug-tobacco is steamed to soften it, stemmed, bundled, dipped in a hot solution of licorice and molasses, sunned, dried, flavored, and then made up into bundles of the required weight, — pound, half-pound, or two-ounce, as the case may be. Each bundle is wrapped in a leaf; pressed in sheet-iron *shapes*; turned, and again pressed; then packed in boxes or tubs, in which they are finally pressed.

For smoking, the tobacco is granulated in a mill or shaved in a fine-cutting machine; stems are ground up with the leaves in the poorer qualities, but these are usually made into snuff.

See CIGAR; SNUFF; TOBACCO-PIPE; etc.

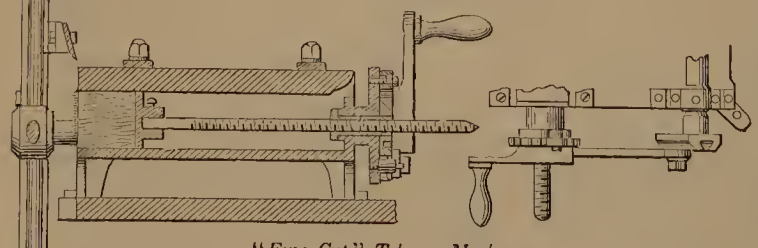
The culture of the poppy at Patna is under license from the English, the whole produce being contracted for in advance, at rates varying with the quality. It flowers in January and February, and the capsule is hacked by a serrated tool in February and March. The opium is rolled into balls, wrapped in poppy-petals, packed in chests, carried to Calcutta, and exported to poison the Chinese — and others.

It has been known to the Chinese only about two centuries, even as a medical prescription.

**To-bac'co-book'ing Ma-chine'.** (*Tobacco.*) A machine which arranges the smoothed leaves of tobacco into symmetrical piles.

In patent No. 133,420, the leaf is fed in upon a pointed convex plate, and stemmed by two shear-cutting disks attached to the bases of two conical rollers, one of which is adjustable. The leaf is then carried by an endless apron down around and pressed upon the booking-roller, which is suspended by the said elastic apron and held up against an adjustable roller. The apron is strained properly by a weighted concave roller. A suspended guard-plate insures the passage of the leaf to the booking-roller, and a knife-cleaner removes the gum from the cutting-disks. See also TOBACCO SHEETING-MACHINE.

Fig. 6486.



*"Fine-Cut" Tobacco-Machine.*

**To-bac'co-cur'ing.** Done, in the first place, in sheds or tobacco-barns. The leaf is very succulent, and requires care and favorable weather. The fine flavor is developed in curing; mildew spoils it, and unfavorable conditions spot and discolor, impairing quality and appearance. Artificial heat is applied in some stages.

**To-bac'co-cut'ter.** 1. A machine for shaving tobacco-leaves into shreds for chewing or smoking:

the former is known as *fine-cut* in this country; the latter is the usual form of smoking-tobacco in Europe, where the granulated tobacco is (or was) not preferred.

Fig. 6486 is a *fine-cut* machine, in which the leaves are driven along a square trough by a plunger, which is moved by a screw, a certain distance between each cut of the knife.

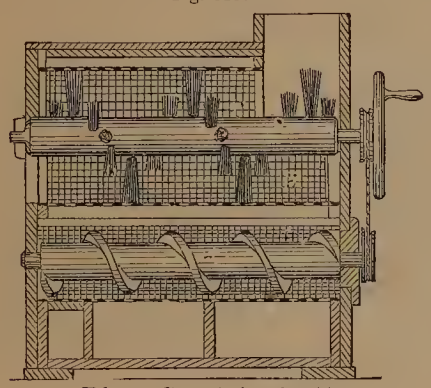
In Spencer's machine, patent 75,805, the stock is carried forward upon an endless apron, and compressed between the upper and lower cylindrical rollers and the inclined, smooth, metallic sides. The knives are carried in contact with an emery-wheel at each revolution. The emery-wheel rotates at high speed within a case which is filled with steam, and has a longitudinal aperture allowing the contact of the knives and wheel, and also the passage of steam to moisten the knives and prevent the accumulation of hard gum thereon.

2. A knife for cutting plug-tobacco into smaller pieces. See TOBACCO-KNIFE.

**To-bac'co Gran'u-lat-ing-ma-chine'.** A machine for grinding tobacco-leaves, to fit them for smoking or making into cigarettes.

Fig. 6487 is a machine to facilitate the manufacture of kinnikinick and cigarette tobacco. The tobacco-scraps from which such tobacco is manufactured are thrown into a hopper, whence they pass into the upper sieve, through which the tobacco which is broken up by the spiral brush is forced, while that portion which is not broken up is carried out at the end of the sieve, together with whatever pieces of wood and other hard substances may have been introduced with the scraps. The fine particles of tobacco and dust pass into and are separated by a lower sieve containing an agitating screw.

Fig. 6487.



*Tobacco Granulating-Machine.*

In patent No. 62,811, the circular closed box contains a sieve revolving by a crank above the box lid. This sieve has triangular holes, and has teeth projecting upward between pins on the lower side of the cross-bar of the yielding bead.

Patent No. 48,680 describes a corrugated beater-roller, which is made to revolve within a vibrating vessel whose sides are composed of wire-cloth on a mesh of like character, so that the tobacco is broken up and delivered in small pieces through the meshes of the wire-cloth into a box below.

Patent No. 133,136 has rotary shear-blades, spirally arranged, which work against stationary shear-blades, cutting the tobacco in shreds, after which a vibrating sieve separates the granulated from the uncut portion.

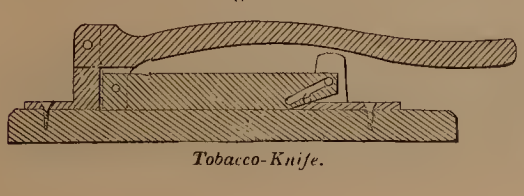
**To-bac'co-grat'er.** A machine for grinding tobacco into small pieces suitable for smoking in pipes.

In one form, the circular closed box contains a sieve revolving by a crank above the box-lid. This sieve has triangular holes, and has teeth projecting upward between pins on the lower side of the cross-bar of the yielding head.

See also TOBACCO-GRANULATING MACHINE.

**To-bac'co-knife.** A knife for cutting plug-tobacco into pieces convenient for the pocket. It is usually a sort of guillotine knife worked by a lever, and cutting downward on to a wooden bed.

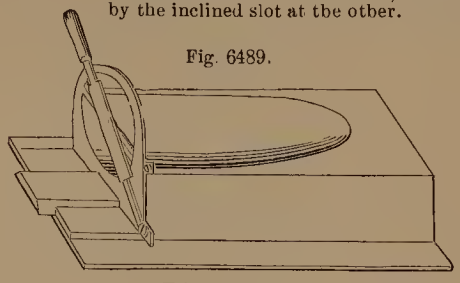
Fig. 6488.



*Tobacco-Knife.*

In the figure, the knife has a draw cut, being pivoted to the side arm of the lever at one end, and directed by the inclined slot at the other.

Fig. 6489.



*Tobacco-Cutter.*

2. Fig. 6489 is adapted for cutting leaf-tobacco for smoking.

**To-bac'co-pack'ing Ma-chine'.** One for making up tobacco into packages, or into shape for packing.

In patent No. 143,545, the material is fed into an endless band-carrying trough, passing under two rollers, which leave the tobacco of a uniform depth. Two knives or combs are pressed down into the tobacco. One holds back the layer of tobacco, the other divides and drives forward a charge, forces it beneath a plate, and leaves it there. A plunger now descends and pushes forward the charge of measured tobacco into a receiver, which has already been automatically provided with a sheet of printed foil and a wrapper from a printing-press arranged at one side. One set of folding-knives then folds one end of the package, which is repressed and completed in another receiver by an additional plunger and another set of folding-knives.

**To-bac'co-pa'per.** Paper made for envelopes for cigarettes, to avoid the flavor of burning cotton or linen. Corn-husk is better than either. Rice-paper is also used.

**To-bac'co-pipe.** The materials which have been employed for making pipes are numerous, from the primitive corn-cob, which is deservedly a favorite, up to the precious and highly ornamented meerschaum. The invention of the pipe, if of nothing else, must be conceded to the Indians. Ancient specimens, buried in the soil, have been found in most parts of North America. So highly was the pipe prized by them, that the red pipe-stone quarry of the Coteau des Prairies was esteemed a sort of sacred neutral ground, where men of all tribes and kindreds might unmolested supply themselves with the precious deposit.

Clay, in its various forms still maintains a pre-eminence, and is used nearly all over the globe for making pipes, the commoner kinds varying in price from 50 cents to $ 1.20 per gross. Those of porcelain are manufactured in Germany, the finer kinds being ornamented by painting, which is in some cases of a very artistic order, commanding a high price.

Red-clay pipes, with wide mouths, are made in Turkey and Algeria. Some are ornamented by stamping, and others are gilded with arabesque designs. The stems are of cherry or jessamine, with amber mouth-pieces, and the whole affair is often elaborately ornamented.

The hookah, or nargileh, has a very large bowl, generally provided with a water-chamber, and may have several long flexible tubes, so as to accommodate a number of smokers at the same time.

These are made in Turkey and Algeria, and often have richly carved bowls of solid silver.

The so-called "brier-root" pipes should be, as their name imports, made from the root of the brier, which is peculiarly incombustible and enduring, but in fact many other species of wood are employed. These are manufactured in Germany and France, particularly in the latter country, where St. Claude, in the Jura, has a monopoly of the commoner kinds. The more expensive carved varieties are made in Paris, and sometimes have a lining of meerschaum.

MEERSCHAUM (which see) is found in Moravia and Spain, but the best is found in Asia Minor, which is the principal source of supply. In 1869, over 3,000 boxes of this material, valued at 345,000 florins, were imported into Trieste from Asia Minor. The manufacture and carving of meerschaum-pipes is principally carried on at Vienna and at Ruhla in Saxe-Cobourg-Gotha. The value of the product at these two places has been estimated at $ 2,000,000 annually. Large numbers are now made in France, conspicuous for the taste and elegance displayed in their carving. Those made of magnesite from the department De Gard are highly esteemed.

The bowls of meerschaums are prepared by first soaking in tallow, then in wax, and finally carving and polishing. Large quantities — it is said, about half of those now sold — are made from the waste. This is ground to a fine powder and boiled with linseed oil and alum, and when the mass is sufficiently cohesive it is cast in molds, carefully dried, carved, and polished, in the same manuer as is the original material.

Amber, which has become so favorite a material for mouthpieces, was brought from the Baltic in the time of Herodotus, 450 B. C

The ordinary clay tobacco-pipe — which, hy the by, has so long a stem that it is called in the slang of the pothouse, a "yard of clay" — is made by hand by a series of processes. The clay is reduced to a plastic condition by pounding with a heavy wooden bar. A workman takes two lumps of clay, of the size of an average apple, and after kneading, rolls them on a table with the palms of his hands till they assume proximately tbe shape of a pipe, — two clay tadpoles with large heads and very long tails. These are placed in a row and are taken in hand by auother workman, who takes a fine steel rod in his left hand, and seizing a "tadpole," draws its long slender tail on to the rod, the fine touch of the right-hand fingers indicating the position of the rod and preventing the protrusion of the wire on either side. The spitted "tadpole" is then laid in the lower half of the metallic pipe-mold; the upper part is then brought down and pressed.

The pipe, being removed, goes to the hands of the finisher, who with a sharp steel instrument smooths the rough clay about the bowl, and cuts away the fins or sharp edges of clay that entered in the parting crack of the mold. The stem is then smoothed and the mouthpiece cut even. The steel wire heing withdrawn, the stem is blown through, to insure that it shall not be a "blind" passage.

Thence to the kiln. One set of hands will make 4½ gross per day.

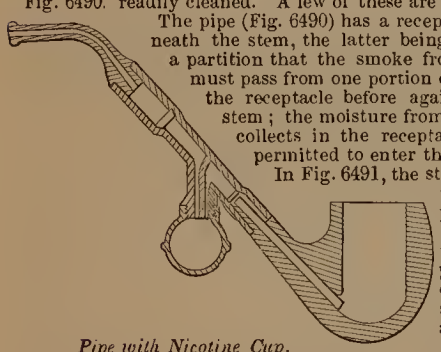
The pipes are baked in a peculiar kiln, being arranged in crucibles or seggars, each of which has six horizontal ledges running around its interior. Upon these ledges rest the bowls of the pipes. while the stems lean against the central pillar. The top is covered iu with a dome, and the crucible contains about 50 gross.

Broseley, in Shropshire, on the banks of the Severn, has been for centuries a chief seat of the clay-pipe manufacture in England, pipes still extant bearing the date 1687, and the names of Richard Legg and John Legg on the bowls. Many of this family still follow the profession of pipe-makers in the quiet little old town. The collection of "broseleys" has been pursued hy some ardent spirits with all the zeal which numismatists devote to their favorite subject, and the progressive alterations in form, and the various marks placed upon them by the old uanufacturers, have been noted with a fidelity which might have brought renown to the observers had their talents been devoted to the examination of palæozoic remains.

The celebrated French Marshal Oudinot was a great collector of pipes; not by any means, however, of "broseleys," of which it is probable he never heard, but of rich and rare specimens.

Many devices have been contrived for collecting the oily matter, containing nicotine, by which pipes become fouled after being some time in use, and enabling them to be readily cleaned. A few of these are illustrated.

Fig. 6490.



*Pipe with Nicotine Cup.*

The pipe (Fig. 6490) has a receptacle for oil beneath the stem, the latter being so divided by a partition that the smoke from the tobacco must pass from one portion of the stem into the receptacle before again entering the stem; the moisture from the upper end collects in the receptacle and is not permitted to enter the bowl.

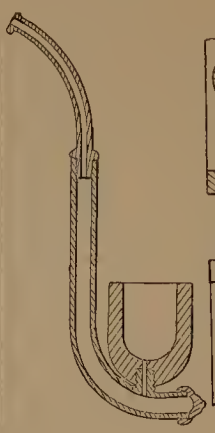
In Fig. 6491, the stem is a metallic tube; the lower part screws into the bottom of the bowl, and is provided with a cap; by unscrewing this and the mouthpiece, it may be cleansed.

**To-bac'co-plug Ma-chine'.** One for adjusting and compacting the leaves into layers of the required form and thickness.

In Fig. 6492, the tobacco is pressed between series of rollers into troughs running on flange-rollers. A large wheel rotating in a transverse direction shifts the troughs on to a series of rollers rotating in the opposite direction, by which they are carried back to the starting end. An inclined knife removes the tobacco from the troughs when sufficiently pressed.

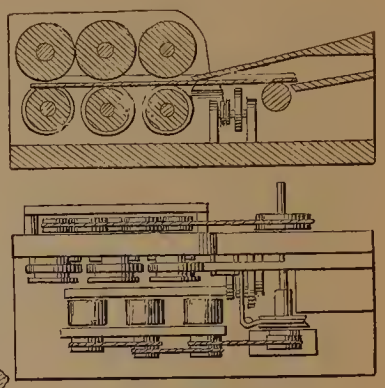
In patent No. 141,562, the tobacco-leaves are laid in a trough, which is placed between two adjustable guide-bars, the leaves resting upon a plate having slots, and beneath another plate having knives, which sink through the layer of tobacco into the said slots, dividing it into plugs. A traversing roller, having shoulders to rest upon the sides of the box, gives the desired

Fig. 6491.



*Metallic-Stem Pipe.*

Fig. 6492.



*Plug-Tobacco Machine.*

pressure, being placed in vertically movable bearings in a horizontally moving carriage.

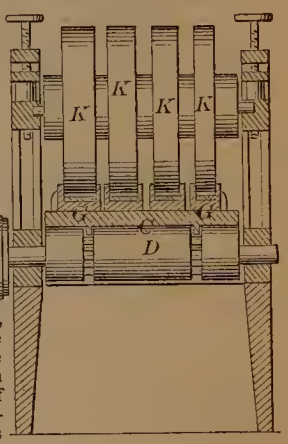
See also patent No. 92,462.

**To-bac'co-press.** These are of several kinds:

1. For pressing granulated tobacco into bags, pockets, or boxes, for convenience of package.

2. For pressing plug-tobacco into shape; the leaves, having been booked and wrapped, are pressed flat, so as to lie compactly in the box or tub (Figs. 6493, 6494).

Fig. 6493.




*Plug-Tobacco Press.*

3. For pressing plug-tobacco in the box or tub, to compact the rolls, cuts, plugs, or twists (Fig. 6495).

In Fig. 6493, the bed *C* reciprocates on the roller *D*, and carries the removable troughs *G*, in which the tobacco is laid to be pressed into the shape of flat plugs by passing under the rollers *K K*.

Fig. 6494 is for making up the leaf-tobacco into plugs, which are pressed into shape and cut off to a length. The sheeted tobacco is fed between revolving aprons, formed of transverse strips of wood, running over corrugated pulleys and slides. A piercer is automatically forced into the plug end at the time it is cut by a guillotine-knife. The rest is then tilted, which raises the edge of the tobacco for removal. The counting is doue by revolving numbered disks operated by the main shaft.

Fig. 6495 is for packing boxes or tubs. The box receives a charge of tobacco and a follower at each stroke of the reciprocating plunger; the wad is delivered at the open bottom of the trunk, being pressed by the frictional contact with the sides thereof. The trunk has clamp-bands, and either of two truuks may be brought in connection with the plunger.

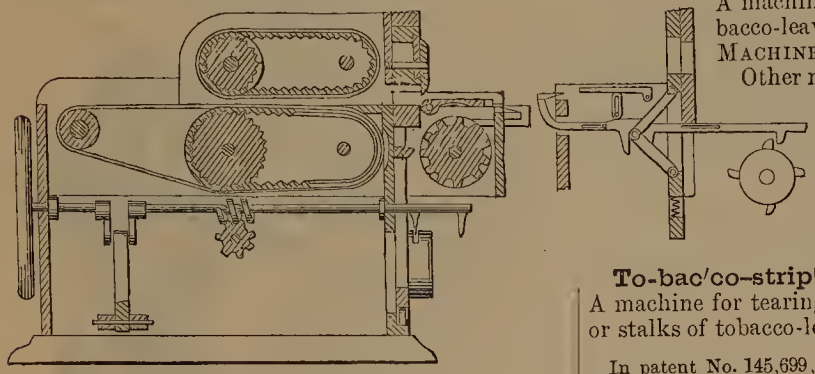
**To-bac'co-roll'ing Ma-chine'.** One for rolling into shape a bundle of leaves to form a filling for a cigar. See patent No. 103,255.

**To-bac'co-sheet'ing Ma-chine'.** Sheeting tobacco consists in laying the leaves out smoothly in sheets. This is done by passing the leaves between rollers which flatten them, devices acting in concert with the rollers to draw out the wrinkles. Sometimes the shape of the rollers has this effect; revolving brushes are used, acting obliquely to the direction of motion of the leaf.

In sheeting tobacco it is sometimes laid in symmetrical piles known as *books*; the operation being known as *sheeting* and *booking*. Tobacco is also *sheeted* and *stripped*, the operation laying the broad portions of the leaf flat, and separating them from or flattening the stem, as the case may be.

Such a machine is one (United States patent, No. 137,170) in which the elastic portion of the rolls presses the leaf without

Fig. 6494.



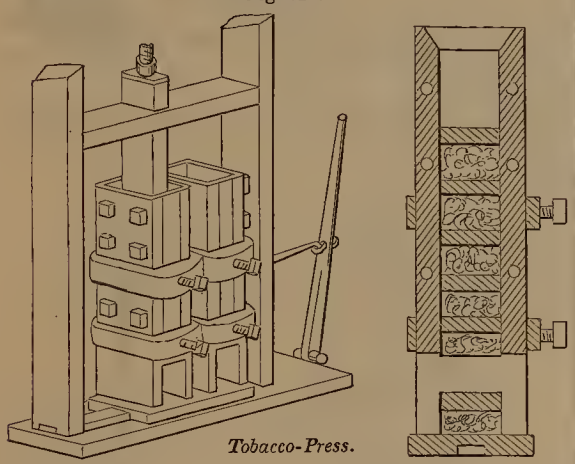
*Plug-Tobacco Pressing-Machine.*

injury to it, while a middle metallic portion flattens the stem. The stem is afterward sheared off.

See also TOBACCO-STRIPPING MACHINE; TOBACCO-BOOKING MACHINE.

Another application of the sheeting-machine is in laying the leaves in layers to form flat plugs; or in laying them of an

Fig. 6495.



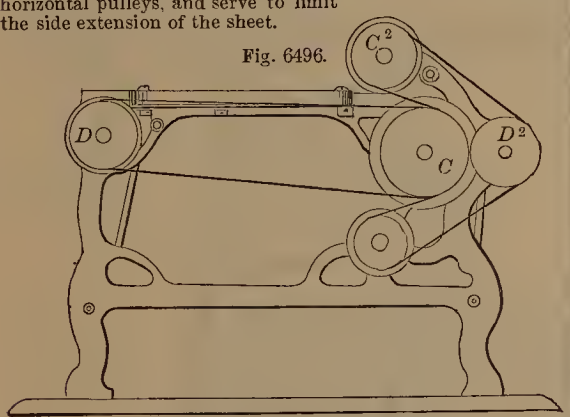
*Tobacco-Press.*

even thickness to be carried to a device which makes them up into twists or twisted plugs.

Another form of tobacco-sheeting machine smooths the leaf, and then cuts it into strips for cigar-wrappers. Such is Fig. 6496.

It smooths out tobacco-leaves into flat sheets for cutting into strips, or piling symmetrically. In the example, the tobacco is carried between the endless metallic belts and passes between the cutter roller and grooved roller. The side belts run on horizontal pulleys, and serve to limit the side extension of the sheet.

Fig. 6496.




*Tobacco Sheeting and Pressing Machine.*

The tobacco-leaves are fed in at the left of the machine, as shown; are carried along past the guide-edge *L*, and pass between the endless metallic belts which run over the rollers *C D* and $C^2$ $D^2$ respectively. These belts consist of endless parallel brass ribbons, and the roller *C* has circular knives which cut the leaves into strips for cigar-wrappers.

**To-bac'co-stem'ming Ma-chine'.** A machine for removing the stems of tobacco-leaves. See TOBACCO-STRIPPING MACHINE.

Other machines depend upon crushing the stem. See also patent No. 68,597, machine for breaking stems of tobacco.

**To-bac'co-stop'per.** A little plug for condensing the burning tobacco in the bowl of the pipe.

**To-bac'co-strip'ping Ma-chine'.** (*Tobacco.*) A machine for tearing or cutting out the main stems or stalks of tobacco-leaves. Also called *stemming*.

In patent No. 145,699, the tobacco-leaf is fed between two rollers having cutting-disks to remove the stems; then passes along, carried by two pairs of endless belts between four other pairs of rollers, when revolving brushes or scrapers loosen the leaf, and it passes on to a fan which automatically deposits the two portions of the stripped leaf in piles.

In patent No. 156,608, the strippers are pivoted upon the frame, and their long arms are connected by a screw, whereby the inner edges of the scrapers may be adjusted to the rolls at will, and held with a yielding pressure.

In patent No. 146,540, the leaves are fed to the separating-cutters, and are delivered upon one side of the machine by means of a pair of endless bands, so arranged over their rolls that when the leaves are divested of their stems they are pressed and smoothed.

In patent No. 141,563, the leaves are passed between rollers having alternate flat and concave surfaces to crush the stems: then between another pair of rollers having knives and brushes, whereby the flattened stems are cut into narrow strips, and the leaf is brushed. Guides prevent the leaf from adhering to the pressing-rollers, and scrapers clean the cutting-rollers.

See also patent No. 122,816, and Fig. 6496.

**To-bac'co-wheel.** A machine by which leaves of tobacco are twisted into a cord. It resembles the hay-band machine, or machine for twisting hempen yarns.

**To'bine.** A stout twilled silk.

**Tod-stove.** (*Qu.* from *tod*, a branch or bush.) A box-stove adapted for burning small and round wood, brush, limbs, and the like.

A six-plate stove for bar-rooms and country stores.

**Toe.** 1. (*Machinery.*) *a.* The lower end of a vertical shaft, as a mill-spindle, which rests in a *step*, or *ink*.

*b.* An arm on the valve-lifting rod of a steam-engine. A cam or lifter strikes the toe and operates the valve; such toes are known respectively as *steam-toes* and *exhaust-toes*.

2. A projection from the foot-piece of an object, to give it a broader bearing and greater stability.

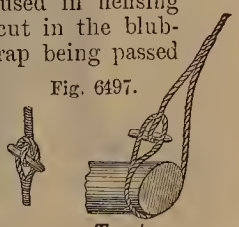
3. A barb, stud, or projection, on a lock-bolt.

**Toe-calk.** A prong or barb on the toe of a horse's shoe, to prevent slipping on ice or frozen ground.

**Toed.** (*Carpentry.*) A brace, strut, or stay is said to be *toed* when it is secured by nails driven in obliquely and attaching it to the beam, sill, or joist.

**Tog'gle.** 1. (*Nautical.*) A short wooden pin, or double cone of wood, firmly fixed in a loop at the end of a rope. By passing the toggle through the eye or bight of another rope, a junction is easily formed and quickly disengaged. It is useful in bending flags for signals, or it is attached to the end of a line to afford a firm hold for the fingers, as in the gunner's lanyard. It is also used in flensing whales, in which a hole is cut in the blubber, the eye of a purchase-strap being passed through and toggled.

Fig. 6497.



*Toggle.*

2. (*Machinery.*) Two rods or plates, hinged together, and employed to transmit a varying force by lateral pressure upon the hinge, which is called the *knuckle*, or knee,

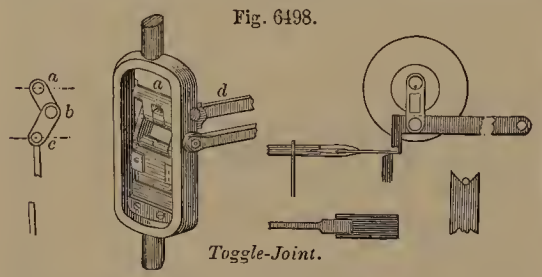
form obvious analogies. See TOGGLE-JOINT; TOGGLE-PRESS.

**Tog'gle-joint.** An elbow-joint. A joint formed by two pieces articulating endways, as the human knee. It is much used in presses: the Stanhope printing-press, and some hay-presses, are instances. See HAY-PRESS, and many other instances under Presses. See list of Presses, page 1784. See also TOGGLE-PRESS.

Fig. 6498 illustrates the toggle-joint, frequently used in place of the screw, in presses.

The two parts *a c* are jointed together at *b*. The part *a* is jointed to the upper part of the press, and *c* to the upper end of

Fig. 6498.




*Toggle-Joint.*

the follower. When the links *a c* form an angle with each other, the follower is in raised position, but when straightened, by depressing a lever *d* connected to the point *b* by a crank-arm, they operate with great power to depress the follower.

**Tog'gle-press.** One in which the platen is moved by the flexion or extension of two bars which unite to form a knee-joint.

This form of press has especial value for many purposes, as the motion of the platen is more rapid at the time when the toggle-bars are starting from the point of their greatest flexion, and, as they straighten out, the power increases and rate diminishes as the point of ultimate pressure on the bale is approached.

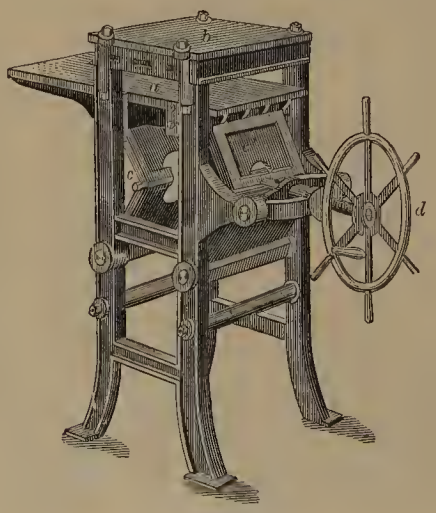
1. (*Printing.*) *a.* A form of press which succeeded the screw used universally until late in the eighteenth century.

One of the most familiar forms of this order of presses is to be found in the Stanhope printing-press, in which the platen is depressed by a toggle and raised by springs. The movement is variously known as a *knuckle*, *knee*, or *elbow* movement. See STANHOPE PRINTING-PRESS, page 1796.

*b.* A press for making electrotype molds from forms of type.

The platen *a* has a projecting table upon which the form and mold are adjusted to each other, and being pushed beneath the fixed head *b* the platen is raised and the impression made by two pairs of toggle-jointed leaves *c c'* operated by a screw and crank wheel *d*.

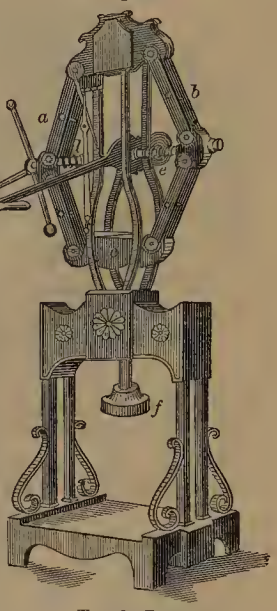
Fig 6499.




*Toggle-Press.*

2. (*Baling.*) A cotton or hay press operating by the action of a toggle-joint. The mode of presentation of the toggle varies, as will be seen in the following examples: —

Fig. 6500.



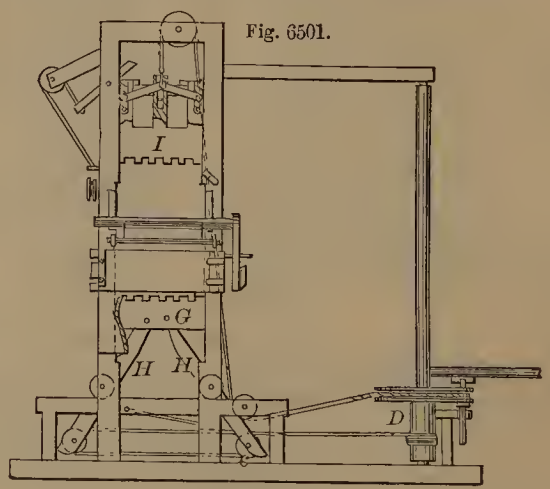

*Toggle-Press.*

In that shown (Fig. 6500), the two toggles *a b* are pivoted to a cross-head *c* at their lower extremities; two oppositely threaded screws *d e* work through corresponding hollow screws at the joints of the toggles, and are turned by a hand-wheel, causing them to approach or recede from each other and raise or lower the cross-head *c*, to which the stem of the follower *f* is connected. If greater power be desired, it is obtained by using the lever *g*, which turns the screws through the medium of a pawl and ratchet-wheel.

In another form, the two members of the toggle *H H* are knuckled into the follower, which, in the illustration, receives motion from two levers which rest by their moving fulcrum rollers on a horizontal beam. The motive cord is passed around pulleys in the lower ends of the levers.

The conditions of this press are the inversion of those of the last. In the former, power on the knee separated the hip and ankle, if the parallel may be allowed, as it may; in the latter case (Fig 6501), the hip and ankle are

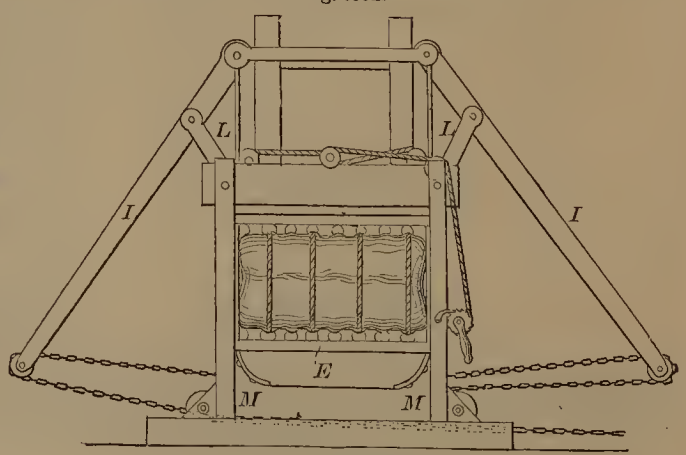
Fig. 6501.




*Toggle-Press.*

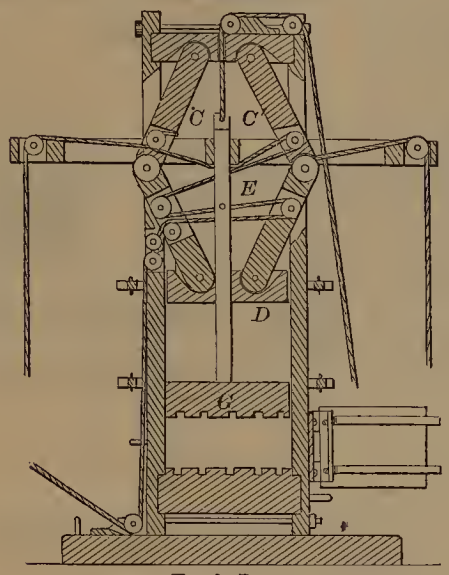
drawn together by the rope and pulleys, and the knee with its follower *G* is elevated. The illustration, Fig. 6501, is that of a

Fig. 6502.




*Overhead Toggle-Press.*

Fig. 6503.




*Toggle-Press.*

beater-press, in which the upper weighted follower *I* is dropped repeatedly upon the stuff in the box, until a certain degree of compactness is attained. Then, the follower *I* being locked in its down position, the bale receives its ultimate pressure from the ascending follower *G*, operated by the toggle *H H*, through the medium of pulleys *c*, rope, and winding-shaft *D*. See also BEATER-PRESS; BALING-PRESS.

In another form (Fig. 6502), the platen *E* is raised by suspension rods *M M* dependent from the ends of levers *I I* which are constituted toggles by means of the rolling fulcrums *L L* which are hinged to the frame. They are operated by chains which pass around rollers at their lower ends and others in the frame.

In Fig. 6503, the toggle-levers *C C* are operated by cords serving to depress the slide *D* to which the platen-rod *E* is attached. The follower *G* has a long stem *E*, by means of which it may be raised when used as a beater. When the beating operation has progressed as far as desirable, the platen-rod *E* is attached to the slide *D* by a pin, and the toggles are brought into requisition to complete the baling.

In still another form (Fig. 6504), the toggle is double acting, pressing upon two followers *a a* which act within their respective boxes. The action is simultaneous in the boxes. Each toggle consists of a main beam *b* and a rolling fulcrum *c*; the adjacent ends of the beams *b b* are simultaneously depressed by the rope which is rove through the pulleys on the levers and the standard *d* respectively.

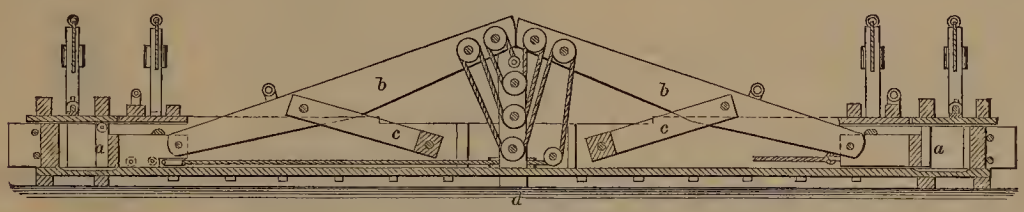
**Toi-li-net'.** (*Fabric.*) *a.* A kind of German quilting.

*b.* A fabric of silk and cotton warp and woolen weft.

**To'ken.** 1. (*Mining.*) A piece of leather with a distinct mark for each hewer, one of which he sends up with each corf or tube.

2. (*Printing.*) *a.* Ten and a half quires, or 250 sheets, of paper printed on both sides.

Fig. 6504.




*Double-Headed Toggle-Press.*

*b.* In some cases, ten quires of paper.

3. A coined medal or piece of metal, intended for currency and issued by a private party.

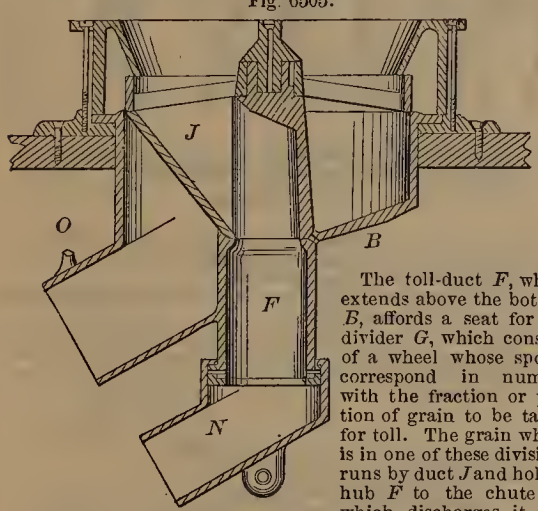
**To'ken-sheet.** (*Printing.*) The last sheet of a token.

**Toll-bar.** A gate or bar placed across a road to stop animals and vehicles till toll be paid.

**Toll-col-lect'or.** 1. A counter at a turnstile or gate to indicate the number of persons passing. See TURNSTILE.

2. A device attached to the feed of a grain-mill to subtract the toll.

Fig. 6505.




*Toll-Collector for Grist-Mills.*

The toll-duct *F*, which extends above the bottom *B*, affords a seat for the divider *G*, which consists of a wheel whose spokes correspond in number with the fraction or portion of grain to be taken for toll. The grain which is in one of these divisions runs by duct *J* and hollow hub *F* to the chute *N*, which discharges it separately from the remainder of the grain, which passes by spout *O* to the stones. There are several other forms.

**Toll-dish.** A vessel of given capacity for taking the toll or proportion of grain ground on shares. A *toll-hop.*

**Toll-gate.** A turnpike gate at which toll is collected.

**Toll-house.** The residence of the toll-taker at a turnpike-gate.

**Tom'a-hawk.** An Indian hatchet.

Fig. 6506.

*Tomahawk.*

Indians are supplied with tomahawks by the governments and traders with whom they deal, and their tastes are ministered unto in the attachment of a pipe to the poll. A hole is drilled through the bottom of the bowl and the poll of the axe, to meet one passing through the length of the handle. A heavy, clumsy pipe and a light, effective little axe. A combination of tastes, — blood and smoke.

**Tom'bak; Tom'bac.** (Malay, *Tambaga*, copper.) An East Indian alloy for cheap jewelry. Copper, 16; tin, 1; zinc, 1. Red tombak: copper, 11; zinc, 1. Arsenic is added to make *white tombak.*

There are a number of other varieties, the constituents and proportions of some of which are given: —

| | Copper. | Zinc. | Lead. | Tin. |
|---|---|---|---|---|
| Tombak for making gilt articles | 82 | 18 | 1.5 | 3 |
| Tombak for making gilt articles | 82 | 18 | 3 | 1 |
| Tombak for making gilt articles | 82 3 | 17.5 | .. | 0.2 |
| French tombak for sword-handles, etc. | 80 | 17 | .. | 3 |
| Yellow tombak of Paris, for gilt ornaments | 85.3 | 14.7 | .. | .. |
| Tombak for the same purpose, from Hanover | 86 | 14 | .. | .. |
| Tombak of the Okar, near Goslar, in the Hartz | 85 | 15 | .. | Trace. |
| Chrysochalk | 90 | 7.9 | 1 6 | .. |
| Red tombak, from Paris | 92 | 8 | .. | .. |
| Red tombak, from Vienna | 97.8 | 2.2 | .. | .. |

**Tom'pi-on.** (From a French word meaning a plug or stopper.) 1. (*Ordnance.*) *a.* A plug fitted to the bore of a gun at the muzzle, to protect it from injury by the weather.

Fig. 6507.

*Tompion.*

*b.* The iron bottom of a charge of grape-shot.

2. (*Lithography.*) The inking-pad of the lithographic printer. *Tompon.*

3. (*Music.*) The plug in a flute or organ-pipe, which is adjusted toward or from the mouth-piece to modulate the tone.

The pitch of the note is determined by the length of the pipe beyond the mouth-piece, and the tompion of the organ pipe allows this distance to be regulated to tune the pipe. The stopping of an organ pipe by a *tompion* lowers the pitch one octave; in effect doubling the length of the pipe. See PIPE; PITCH.

**Tom'pon.** The inking-pad of the lithographic printer.

**Tom-tom.** The form of *kettle-drum* used by the Chinese, Hindoos, and Cingalese. The bowl is of sonorous bronze, and the head is of parchment. It is usually beaten by the hand, and resembles the *darabooka* of ancient and modern Egypt, which is in use under allied names throughout the Arabic tribes. The *tom-tom* is, however, placed on the ground, while the *darabooka* has a handle by which it is grasped by the *left* hand, being played by the *right* hand. The *darabooka* is thus a connecting link between the *drum* proper and the *tambourine*. It is perhaps more generally called *tam-tam*.

The *tom-tom* is the original kettle-drum, and in some shape is found among most nations, savage and comparatively civilized.

**Ton.** In America the usual ton is 2,000 pounds avoirdupois, — 20 cwt. of 100 pounds each.

In the Eastern States, 2,240 pounds — 20 cwt. of 112 pounds each — is usual with coal, and perhaps some other things. This is the *long ton.*

The mining ton of Cornwall is 21 cwt. of 112 lbs. Tin is sold in Cornwall by the 1,000 lbs.

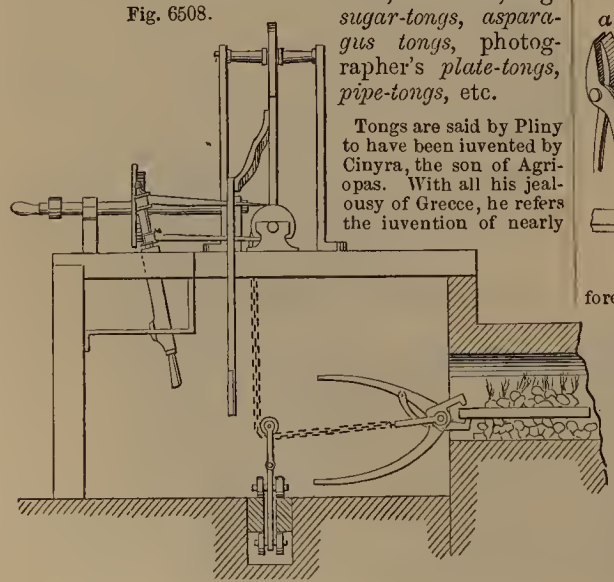
**Toned Pa'per.** Tinted paper. The glaring white taken off by a creamy tint.

**Tong.** The catch to a buckle. See TONGUE.

**Tong-kang.** (*Nautical.*) A Malay or Chinese boat of a certain kind.

**Tongs.** A tool consisting of two parts joined by a pivot, and used for grasping objects; generally those that are hot, as *blacksmith's tongs* (*h*, Fig. 6511), *crucible-tongs*, and *fire-tongs:* the term is not confined to such, however; e. g. *sugar-tongs, asparagus tongs*, photographer's *plate-tongs, pipe-tongs*, etc.

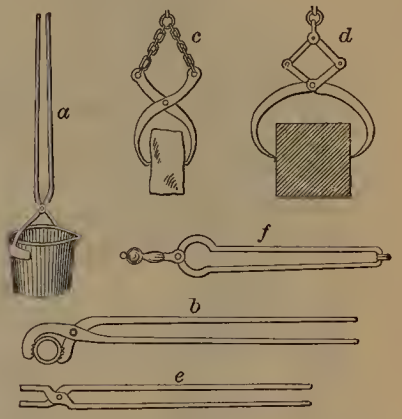
Fig. 6508.



*Apparatus for Drawing Iron from the Fire.*

Tongs are said by Pliny to have been invented by Cinyra, the son of Agriopas. With all his jealousy of Greece, he refers the invention of nearly all the known tools of his time to the Greeks, with an occasional notice of a protest being entered by the Egyptians and Phœnicians. The latter will seem very reasonable to us who read of the progress attained by each of these nations as recorded in Scripture history, and on the monuments of the former.

Fig. 6509.



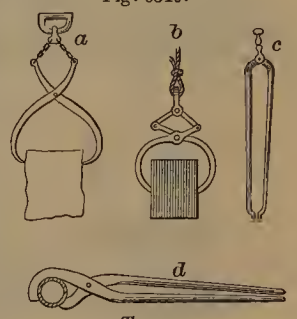

*Tongs.*

The ancient fire-irons were the *fire-fork*, two-pronged; *fir-scovel* (Anglo-Saxon) or *fire-sholve* of the sixteenth century; and *Fyr-tang* of the Anglo-Saxons; the *tenalea, tenecula*, of Du Cange.

Crucible tongs (*a*, Fig. 6509) have curved plates adapted to the shape of the sides of the crucible.

In the pipe-tongs *b* the jaws are so made that the pipe is grasped between the recess of one jaw and the end of the other. The leverage on the short jaw makes a very tight pinch. See Figs. 3747-49, 3753.

Fig. 6510.




*Tongs.*

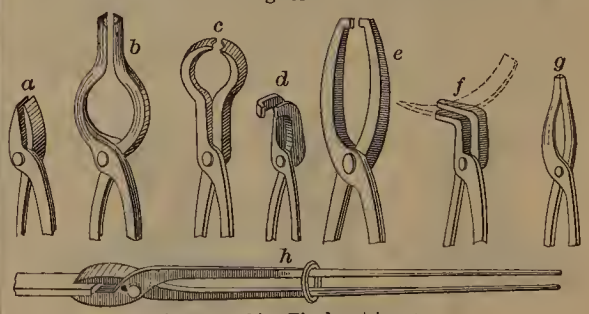
Similar in construction is the clasp which engages the staple on the top of a monkey, the latter being released to fall on the head of a pile when the tongs are opened (*B*, Fig. 3717).

Fig. 6508 shows an arrangement of apparatus for drawing iron from the fire. The windlass has a pulley and transversely movable support secured in the floor. Its object is to operate tongs to draw heated iron from the furnace. See also a CLUTCH for suspending tackle, Fig. 1351, page 578.

A familiar illustration of lifting-tongs is the ice-tongs (*c*, Fig. 6509), which are large iron nippers closed by drawing upon a chain attached to both handles.

On a larger scale substantially the same device *d* is used for lifting stones, etc., the pull on the shackle connecting the two links, drawing together the upper ends of the arms and closing the points on the object to be lifted. They loose their hold upon the stone as soon as it is placed in position, and are therefore useful in laying submerged foundations and breakwaters, as the *lewis* would require the services of a diver to detach it. See LAZY-TONGS; SNAP-DRAGON.

Fig. 6511.



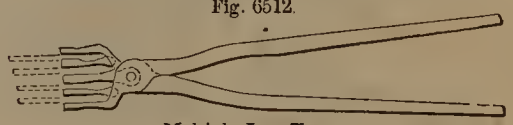

*Tongs used by Blacksmiths, etc.*

The ordinary fire-tongs *f* have one jointed leg, and do not require special description.

Fire-tongs are mentioned as a part of the furniture of Solomon's Temple, 1004 B. C. They were made by Hiram Abiff.

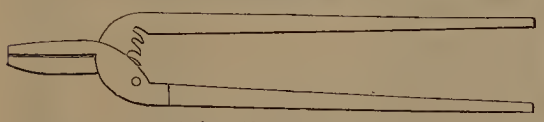
*a* (Fig. 6510), lifting-tongs or *dog*. *c*, domestic fire-tongs.
*b*, lazy-tongs. *d*, pipe-tongs.

Fig. 6512.



*Multiple-Jaw Tongs.*

Fig. 6513.



*Adjustable-Jaw Tongs.*

Fig. 6511 shows various forms of tongs used by blacksmiths.

*a*, *h*, *flat-bit tongs;* the jaws are flat, and a ring or coupler is placed upon the handles or *reins* to maintain the grip upon the work.

*b*, *angular-bit tongs;* useful for holding round or square bars, and also bolts, the heads being placed within the swell of the jaws.

*c*, *pincer tongs;* for similar uses.

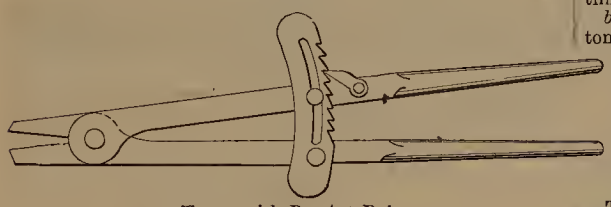
*d*, *crook-bit tongs;* used by cutlers, etc.

*e*, *hammer tongs;* for handling work punched with holes.

*f*, *hoop-tongs:* for holding hoops or riugs.

*g*, *smith's pliers;* for grasping light work.

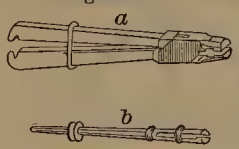
Fig. 6514.



*Tongs with Ratchet-Rein.*

Fig. 6512 is a tongs for grasping several objects simultaneously. The two outer tongs are rigid to the arms, and the central tongues are pivoted so as to oscillate freely in the plane of movement of the outer ones.

Fig. 6515.




*Tongs used by Watch-makers, etc.*

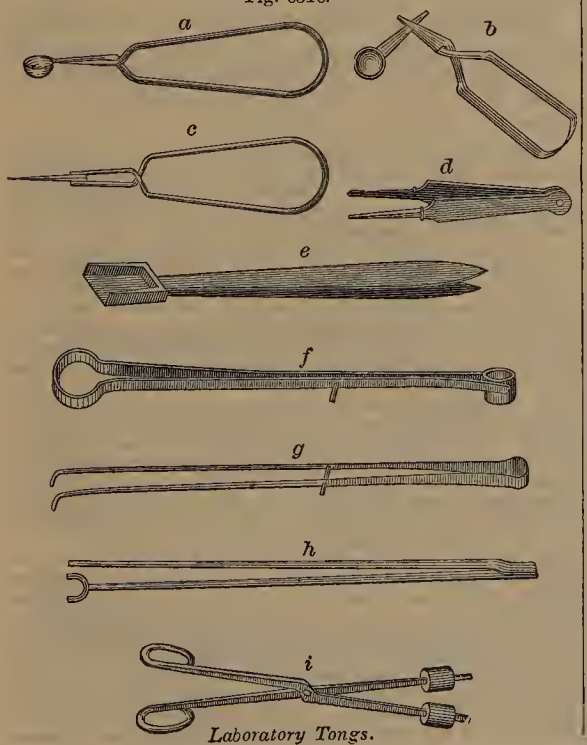
Fig. 6513 is adjustable by the engagement of the pintle which is fast to one jaw with either one of several notches in the other jaw, so as to vary its capacity for grasping.

Fig. 6514 has a ratchet and pawl on the respective handles, which are a substitute for the *coupler* or sliding ring.

*a b* (Fig. 6515), pin-tongs, closed by a ferrule sliding on the stem, used for holding small wires to be filed, and for various manipulations. *b* is also used as a drill-stock in connection with the bow-drill.

In Fig. 6516 are illustrated a variety of laboratory and metallurgical tongs.

Fig. 6516.




*Laboratory Tongs.*

*a b*, spring-steel tongs for holding platinum cups or spoons in a flame.

*c*, spring-steel tongs with platinum points, for use with blow-pipe, etc.

*d*, brass tongs, with fine points.

*e*, iron tongs, with spoon handle.

*f g*, cupel tongs, of elastic iron, for moving cupels into or out of the muffle.

*h*, scorifier tongs, for lifting scorifiers or cupels and arranging them in the muffle.

*i*, iron tongs mounted with cork, for lifting hot flasks.

Fig. 6517 shows tongs, etc., used in the bottling of soda-water and other effervescent beverages.

*a* is a tying lever for champagne bottling.

*b c d*, bottling-tongs.

Fig. 6517.

*Bottling Pliers and Tongs.*

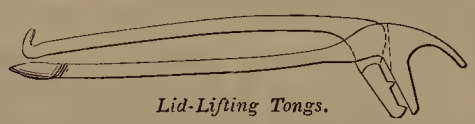
*e*, siphon-tongs for holding head of siphon-bottles.

Fig. 6518 is a tongs for lifting stove-lids.

**Tongue.** 1. (*Vehicle.*) The single shaft or pole which, in two-horse vehicles, is attached to the fore-carriage, and is the means of guiding and drawing.

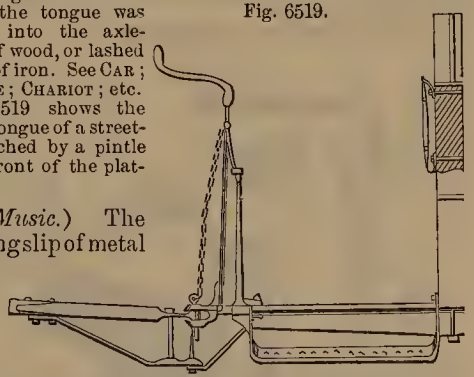
The tongue or pole was the universal appendage to ancient vehicles. Horses, cattle, or asses were yoked to the tongue. When traces were used, in the case of horses, there was only one to each animal, and that on the side next to the tongue. They pulled by the yoke, which was fastened by a vertical pin to the tongue. The rear end of the tongue was tenoned into the axle-tree, if of wood, or lashed to it, if of iron. See CAR; CARRIAGE; CHARIOT; etc.

Fig. 6518.



*Lid-Lifting Tongs.*

Fig. 6519.



*Tongue of Street-Car.*

Fig. 6519 shows the jointed tongue of a street-car, attached by a pintle to the front of the platform.

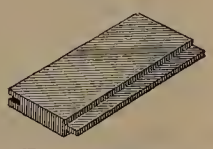
2. (*Music.*) The vibrating slip of metal in a metallic frame, giving a musical tone in an accordeon, concertina, melodeon, parlor-organ, etc. See FREE REED.

3. The pin in a buckle which pierces and holds the strap.

Buckles and brooches (*fibulæ*) with movable tongues were common in Rome. See BUCKLE.

4. (*Railroading.*) The short movable rail of a switch, by which the wheels are directed to one or the other lines of rail. See SWITCH.

Fig. 6520.



*Tongue and Groove.*

5. (*Carpentry.*) *a.* A fin on the edge of a plate or board, adapted to fit into a groove of an adjacent board. Also used in sliding parts of machinery.

*b.* The tapering, projecting end of a timber, worked down to fay upon an edge, or scarf to another timber.

6. (*Nautical.*) *a.* The upper main piece of a built mast.

*b.* A rope spliced into the upper part of a standing back-stay.

7. The clapper of a bell.

8. The movable arm of a bevel, the principal member being the *stock*, which forms the case when the instrument is closed. See BEVEL.

9. The pointer of a balance.

**Tongue-and-groove Joint.** A mode of joining wooden stuff in which a long fin on the edge of one board is made to fit into a corresponding groove on the edge of the other board. See JOINT; also Fig. 6520.

**Tongue-bit.** (*Manege.*) One having a stiff *mouth*, to which is attached a plate or shield so placed as to prevent the horse getting his tongue over the mouth-piece.

Fig. 6521.

*Tongue-Chains.*

**Tongue-chains.** The chains by which the fore end of the tongue is supported from the hames of the *wheel-horses*. They may be distended by the *spreader-stick*.

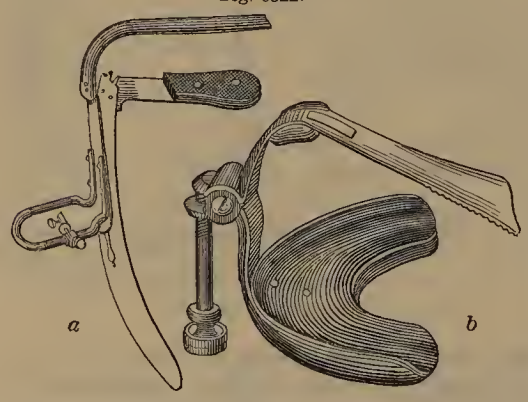
**Tongue-com-press'or.** A clamp for holding down the tongue during dental operations on the lower jaw. The sublingual and maxillary ducts may be at the same time closed, by applying to them rolls of bibulous paper before applying the compress. See TONGUE-SPATULA.

**Tongued-chis'el.** A boring-chisel which has a long, downwardly projecting blade, and shoulders which form reamers.

**Tongue-de-press'or.** (*Surgical.*) An instrument which has a socket to go beneath the lower jaw and form a fulcrum for the pivoted spatula which rests upon and holds down the tongue during oral, laryngeal, and esophageal examinations and operations. A *tongue-spatula*.

*a*, the Elsburg pattern.
*b*, Church's self-holding tongue-spatula.

Fig. 6522.




*Tiemann's Tongue-Spatulas.*

**Tongue-spat'u-la.** See TONGUE-DEPRESSOR.

**Tongue-sup-port'.** A device on the tongue-hounds of a wagon to keep the forward end of the tongue elevated and prevent its weight bearing on the necks of the horses.

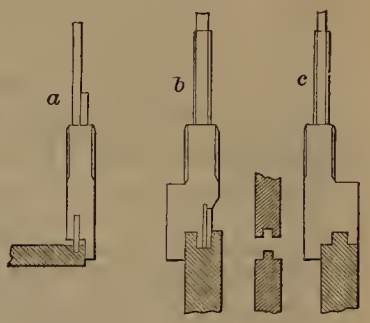
In the example (Fig. 6524), it is a bar, the middle of which rests upon the coupling-rod, and its ends beneath the fore-axle and tongue respectively.

**Tongue-test.** 1. (*Electricity.*) A test familiar to electricians, determined by the application of a wire to the tongue, which gives a sensation, sharp or otherwise, according to the condition of the line.

2. (*Engraving.*) A test of pyroligneous or nitric acid, used in determining the strength of an etching solution.

**Tongu'ing and Groov'ing Planes.** (*Carpentry.*) Planes in pairs, adapted for forming tongues and the corresponding grooves into which they are received on the edges of boards, etc.

Fig. 6523.

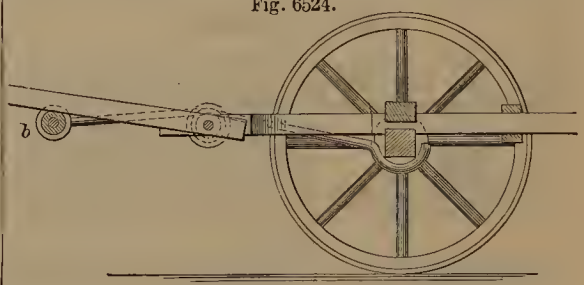



*Tonguing and Grooving Planes.*

The tonguing-plane *c* has a recessed bit which cuts away two strips at the sides of the plank, leaving the central part, which forms the tongue, untouched. The grooving-plane *a b* has a narrow bit, which forms a channel in the wood. The stocks of both have a ledge projecting below the sole, which serves to determine the distance of the tongue or the groove from the edge of the board. Each is provided with bits of different sizes.

**Ton'ing.** (*Photography.*) The treatment of a positive photographic print with a weak solution of gold, in conjunction with other modifying chemical

Fig. 6524.




*Tongue-Support.*

salts, by which the whole or a portion of the deposit of metallic silver is replaced by metallic gold in fine division. The effect is to give permanency to the print, subduing and modifying the disagreeable color, and substituting various shades of purple, black, blue, brown, and gray.

**Ton'nage.** (*Nautical.*) The carrying capacity of a vessel. It is actually equivalent to the difference between the weight of the water displaced by the vessel when light, and that displaced by her when loaded to the greatest safe depth of immersion.

Different rules for calculating the tonnage have been legally established in different countries, some of which have frequently given results varying widely from the true amount which might be safely carried. In deep, full-built ships the actual capacity was always largely in excess of the government-registered tonnage. More recent laws have, in a great degree, remedied this error, but it is extremely difficult, if not impossible, to contrive any general rule by which perfect exactness can be attained.

The rule established by law in the United States, under the Act of 1799, and which continued in force until superseded by that given in the law of May 6, 1864, provided that from the extreme length of the vessel there should be deducted three fifths of the breadth; the remainder was multiplied by the breadth, and the product by the depth, which, in the case of a double-decked vessel, was arbitrarily assumed as being equal to one half the breadth; the latter product was then divided by 95, and the quotient was taken as the legal tonnage on which tonnage dues were to be paid. It was thus made the interest of owners to build excessively deep ships, the law in this way discriminating in favor of clumsy, slow, and inefficient ships, and discouraging attempts at improvements in model.

By the Act of May 6, 1864, vessels are, for the purpose of ascertaining their tonnage, divided into six classes, according to length, those in each class being divided into a certain number of equal parts, or transverse sections, to which different values are assigned in computing the total tonnage of the vessel; the actual depths between decks are measured and taken as factors, and any closed-in space on or above the upper deck, and capable of receiving cargo, etc., is included in the measurement. The dimensions are all taken in feet and decimals of a foot, and the number 100 is used as the final division for ascer-

taining the capacity of the ship in tons, instead of 95, as in the old law.

Class 1. Vessels under 50 feet long, divided into 6 equal parts.
Class 2. Vessels 50 to 100 feet long, divided into 8 equal parts.
Class 3. Vessels 100 to 150 feet long, divided into 10 equal parts.
Class 4. Vessels 150 to 200 feet long, divided into 12 equal parts.
Class 5. Vessels 200 to 250 feet long, divided into 14 equal parts.
Class 6. Vessels over 250 feet long, divided into 16 equal parts.

The details for making the measurements and calculations are too long to be inserted here, but may be found in "Revised Statutes of the United States," 1875, pages 803-806.

The rule adopted in England by the Merchant Shipping Act of 1854 is essentially the same as that established in this country; the measurements are made in feet and decimals, and the principles of calculation are identical. Vessels are divided as follows: —

Not exceeding 50 feet in length, into 4 parts.
Not exceeding 120 feet in length, into 6 parts.
Not exceeding 180 feet in length, into 8 parts.
Not exceeding 225 feet in length, into 10 parts.
Over 225 feet in length, into 12 parts.

In steam-vessels the length, breadth, and hight of the engine-room are multiplied together, the product divided by 100, and the result deducted from the gross tonnage. The space occupied by a propeller-shaft is considered as a part of the engine-room.

It should seem that the American method, employing, as it does, a greater number of divisions for the same length, should be slightly more accurate than the English, or afford at least, on the average, a somewhat nearer approximation to the true capacity of a vessel; either, however, may be relied on generally as coming within 4 or 5 per cent of the truth. This difference may, in extreme cases, amount to 10 or 12 per cent, a trifling error as compared with those incident to the old system.

The ton measurement upon which freight is charged is calculated at 40 cubic feet; the difference between that and the ton of 100 cubic feet, or that of the register, represents the dead weight or displacement of the ship when light, or 60 per cent of the whole, 40 per cent only being available flotative power for cargo.

**To-nom'e-ter.** An instrument, invented by Scheibler, for determining the exact number of vibrations per second which produce a given tone, and for tuning musical instruments.

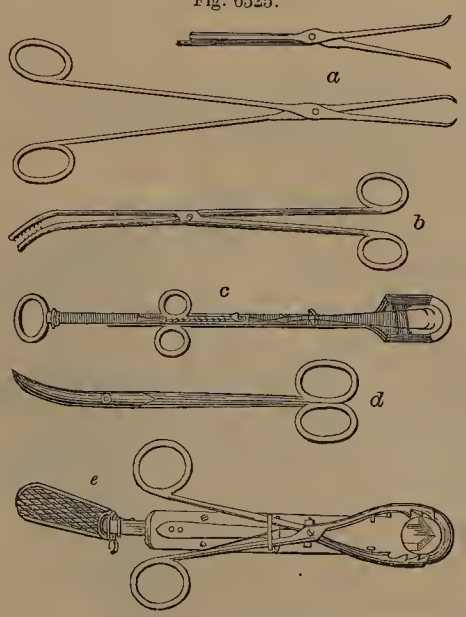
It consists of a set of 65 tuning-forks, any two consecutive ones of which differ in pitch by 4 vibrations per second. The lowest of the series makes 256 vibrations, and the highest 512, completing an octave. To determine the pitch of a given string its note is compared with those of the diapasons above and below it in sound. By counting the resulting beats it will soon be referred to a place between some two of the series, and by comparing the number of beats with each of these two successively, its exact place will readily be inferred. In tuning a string to a given pitch an analogous process is pursued.

An instrument of this kind, invented by the late S. D. Tillman, for illustrating visibly the theory of musical scale and of musical temperament, is described in "Barnard's Report, French Exposition," pages 471-478.

The auditory capacity of the human ear appears to range over about 12 octaves; the gravest audible note representing about 15 vibrations, and the most acute 48,000 per second. This capacity varies in different individuals, some ears being sensible to more acute sounds than others. Incapacity for hearing certain sound vibrations is termed *pitch deafness*. There is reason for supposing that persons whose ears are sensitive to very acute sounds are least able to hear very grave notes, and *vice versa*.

The auditory range of many animals is doubtless very different from that of man. Many persons are insensible to the scream of the bat; it is too acute, but the sound must be perfectly audible to the bat itself. Assuming this animal to have an auditory range of 12 octaves, and that its scream stands midway of the scale, it would be capable of hearing notes 6 octaves higher than those audible to man, — extending up to 2,500,000 vibrations per second. Whales appear to be able to communicate with each other at great distances, and it has been inferred that these animals have the power of emitting sounds too grave to be audible to the human ear, but perfectly distinct to them. See also SONOMETER.

Fig. 6525.




*Tiemann's Tonsil Instruments.*

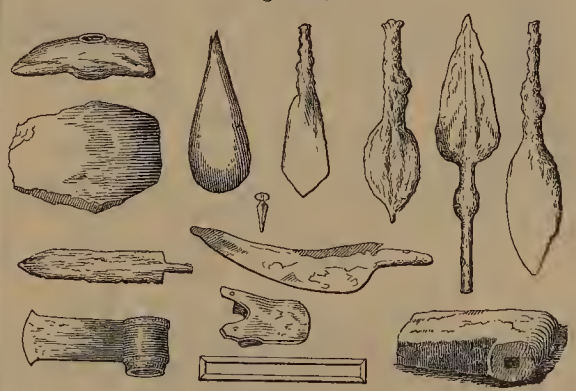
**Ton-sil'o-tome.** (*Surgical.*) A knife for operations on the tonsils; follicles situated between the pillars of the *velum palati* and projecting into the isthmus of the throat.

*a*, tenaculum forceps for seizing. *Vulsellum.*
*b*, Musseux's seizing forceps.
*c*, Billings' tonsilotome.
*d*, tonsil-scissors, curved on the flat.
*e*, Hamilton's tonsilotome.

**Tool.** 1. An implement adapted to be used by one person, and depending for its effect upon the strength and skill of the operator; or, as defined by Webster, "any instrument of manual operation." It is, however, exceeding difficult to define the line separating tools from machines, and of late it has become usual to embrace in the general term *machine tools*, such machines as the *lathe*, *planer*, *slotting-machine*, and others employed in the manufacture of machinery. See MACHINE.

Fig. 6526 represents a number of bronze and stone tools taken from the excavations of the buried cities of Mesopotamia. They

Fig. 6526.



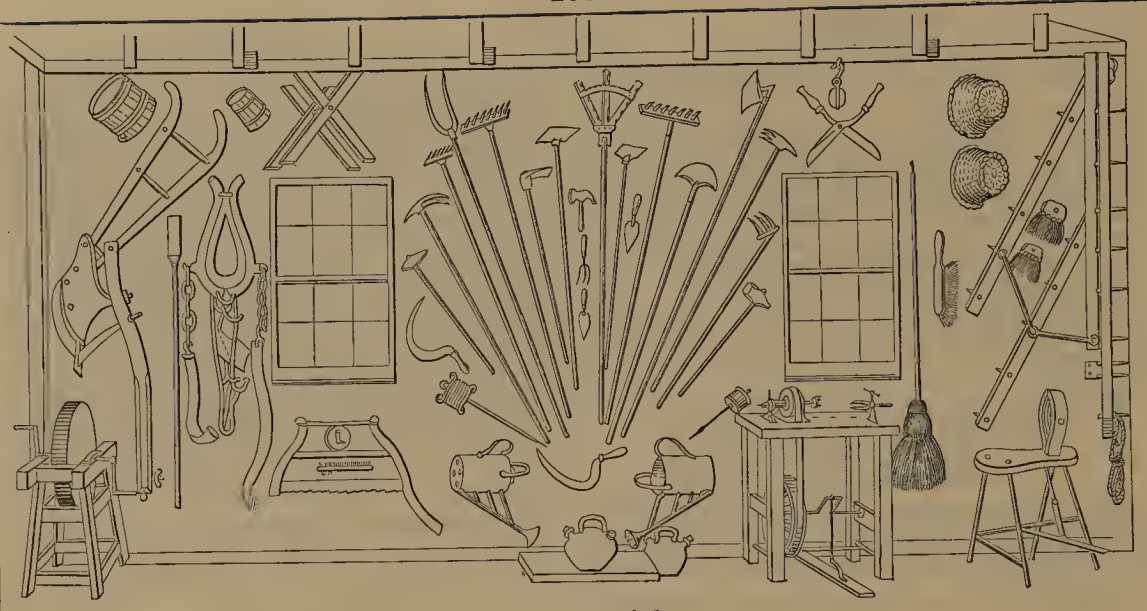
*Chaldean Tools.*

are knives, spears, a sickle, hatchets, and a piece, evidently a hinge of a door. See *b c*, Fig. 2510, page 1104.

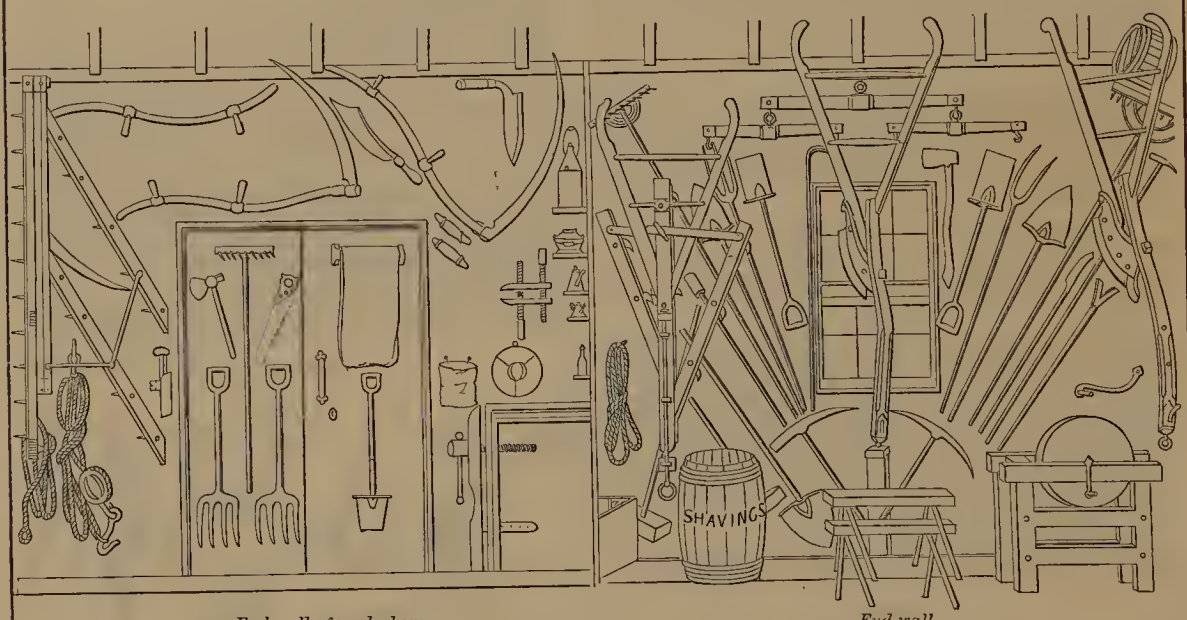
Plate LXX. shows an arrangement of farming-tools on the ends and sides of a tool-house. See also STONE-WORKER'S TOOLS.

William Fairbairn, the celebrated machinist, states that when he commenced his career, at the beginning of the century, the human hand performed all the work that was done in the way of building machinery.

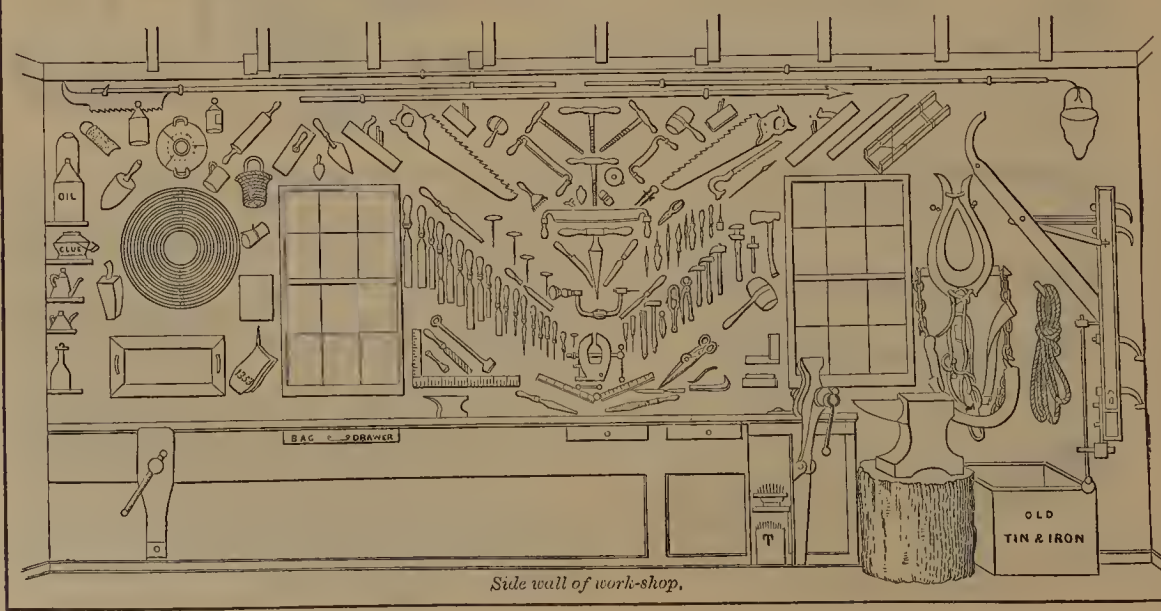
Bramah, the maker of the Patent Lock, originated many descriptions of labor-saving machinery. He found it necessary to give the greatest exactness to every part of the ward and key of this celebrated lock. This he found very difficult to do without employing the very best workmen; and their charges were so exorbitant, that his invention was in a fair way of dropping out of use on account of expense. In this dilemma, he was forced to turn his attention to the introduction of machinery to produce with unerring nicety the different parts of the complicated little apparatus with which his name is yet associated. The workshop in which the many ingenious contrivances to perform this work with speed were invented may be



*Side wall of work-shop.*




*End wall of work-shop.* *End wall.*




*Side wall of work-shop.*

ARRANGEMENT OF TOOLS IN A FARMER'S TOOL-HOUSE.

PLATE LXX.

*See page 2591.*

said to have been the training-school for the early machinists, whose labors have, within the present century, built up the mechanical greatness of England. Accuracy of machine-work before his day was utterly unknown. Watt had the greatest difficulty in getting his first model of the steam-engine constructed with sufficient truth to work; its cylinder was not bored, but hammered, and the piston could not be made to fit. The pumping-engine made a tremendous noise, and much astonished the spectators, who regarded it as one of the most remarkable and interesting parts of the performance. Watt knew better, and would have loved a noiseless machine, but was so beset by open condemnation, faint praise, and legal botheration, that he kept his own counsel, and let the vulgar stare and wonder.

The invention of the famous fixed slide-rest by Maudslay, the journeyman, who learned his trade with Bramah, was the first step in a series of inventions leading toward the same end. Maudslay was the man who executed, from the drawings of the elder Brunel, the series of labor-saving machines at present at work in Portsmouth Dockyard for the manufacture of ships' blocks. (See BLOCK-MAKING MACHINE.) These ingenious machines, forty-six in number, were, only a few years ago, the curiosities of the place, and may be, for aught we know, yet. They were the first ever set up in a public yard, and, although they have been at work for sixty years, they remain still in good working order. Maudslay afterward, in conjunction with his partner Field, founded in Lambeth Marsh the famous firm which is still carried on under their names.

Clements was another inventor who learned his art in the school of Bramah, and afterward worked for Maudslay and Field. This ingenious machinist invented the planing-machine, without which no perfect plane can be made. The value of such a machine is incalculable. Indeed, upon the truth of the plane depends the whole value of modern machinery. Of old, by chipping and filing, an attempt to approach the plane was made, but of course perfect accuracy was out of the question.

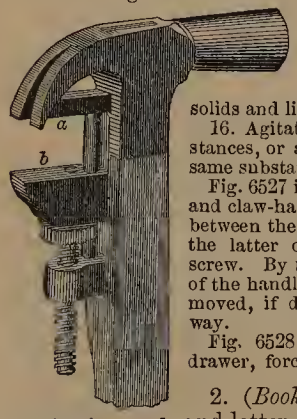
Another pupil of Maudslay was Nasmyth, the inventor of the STEAM-HAMMER (which see).

Joseph Whitworth, the inventor of the gun bearing that name, improved on Clements's planing-machine (see PLANING-MACHINE) in his "Jim Crow" planer, and also invented many ingenious and useful tools and appliances now commonly used in the workshop. See list of METAL-WORKING TOOLS, pages 1425, 1426.

The following general classification of tools, according to their functions and modes of action, has been proposed by a writer in the "Scientific American":—

1. Geometrical tools, for laying off and testing work, as squares, gages, compasses, drawing and surveying instruments, etc.
2. Percussion tools; as the hammer, etc.
3. Compression tools; for pressing, rolling, polishing, etc.
4. Puncturing tools; needles, awls, punches, etc.
5. Cutting tools, including saws.
6. Combined percussion and cutting tools; as the axe, hoe, and scythe.
7. Combined compression and cutting tools; such as planes, shears, etc.
8. Abrading tools; as whetstones, and also that class of drills which act by abrasion.
9. Forming tools; molds for casting, formers for sheet-metal, dies, etc.
10. Motor tools; as the lever, screw, pulley, and in general those employed to impart motion to other tools, to cause a blast, as bellows, and for like purposes.
11. Holding tools; which employ adhesion or compression for supporting in a fixed position materials to be operated on by other tools. This embraces vises, lathe-chucks, and vessels for containing liquids.
12. Separating tools, as sieves, filters, fanning-machines.
13. Directing tools, used as guides for other tools; such as the miter-box, for guiding the saw in cutting miters: funnels for directing the flow of liquids are included in this class.
14. Weighing-tools; scales, balances, and instruments for determining specific gravity.
15. Implements for measuring solid contents; measures of all kinds used for determining the volume of solids and liquids.
16. Agitators; for mixing different substances, or agitating the particles of the same substance among each other.

Fig. 6527.




*Combination-Tool.*

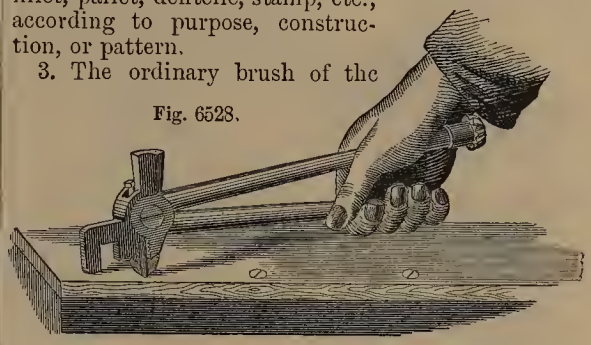
Fig. 6527 is a combined monkey-wrench and claw-hammer. A nut may be grasped between the fixed and movable jaws *a b*, the latter of which is operated by the screw. By unloosing a screw at the back of the handle, the wrench part may be removed, if desired to have it out of the way.

Fig. 6528 combines a hammer, nail-drawer, forceps, wrench, etc.

2. (*Bookbinding.*) The stamping and letter appliances of the finisher. Known as hand, hand-letter, lettering, roller, edge, fillet, pallet, dentelle, stamp, etc., according to purpose, construction, or pattern.

3. The ordinary brush of the painter, consisting of bundles of bristles tied by string or binding wire to the thick end of a cleft handle.

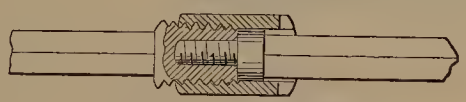
Fig. 6528.



*Combined Tool.*

The larger sizes are, however, more commonly known by their ordinary name of brush, the term *tool* being generally restricted to smaller sizes, as *sash-tools*, etc.

Fig. 6529.

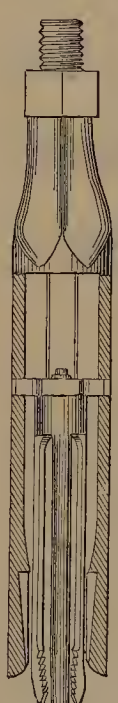


*Coupling-Tool for Drilling.*

**Tool-car.** (*Railway.*) A car carrying an equipment for repairing, replacing on the rails, or removing débris in case of accident. It is a car that railway-men are always glad to have stand idle. It is furnished with cables, ropes, and blocks of various sizes. Jack-screws and crow-bars, picks and shovels, axes, spikes, replacing frogs, vise and set of machinist's tools, and numerous unmentioned appliances.

Fig. 6530.

**Tool-coup'ling.** A screw coupling by which a drill, for instance, is connected to the bar, rod, haft, or whatever the handle may be properly called in a given case.



*Tool-Extractor.*

In Fig. 6529, the reduced end of a shaft is screwed into the enlarged end of another shaft, the former having a collar upon it just back of a screw, and the outer surface of the latter having a thread cut upon it. A sleeve surrounds the two ends thus screwed together, and is screwed upon the external screw of the latter shaft until an internal flange at the opposite end is forced up against the collar on the former.

Fig. 6531.

*Tool-Extractor for Wells.*

**Tooled Ash'lar.** (*Masonry.*) Ashlar with its face chisel-dressed into parallel ridges and hollows.

**Tool-ex-tract'or.** An implement for recovering from drilled holes broken tools or portions of rods which may have become disconnected and fallen to the bottom. Two kinds are shown under GRAB, page 1000. Others are shown under WELL-BORING TOOLS; and ARTESIAN-WELL, Fig. 384.

In Fig. 6530, the ratchet-rods catch the tool, and the action of raising presses the rods inward.

Fig. 6531 has a hollow die or screw-socket which taps its way on to the end of a rod in the hole,

and thus becomes attached to it, so as to enable its withdrawal.

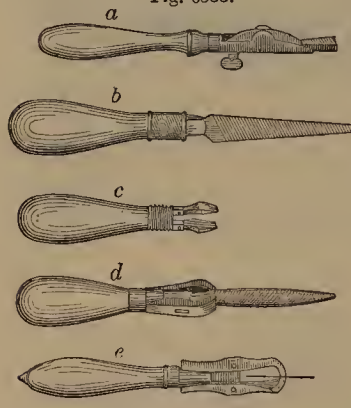
Fig. 6532.

*Nasmyth's Tool-Gage.*

**Tool-gage.** Nasmyth's tool-gage, for testing the angularity of the cutting-face of iron-turning tools, has a bed for the shank of the cutter and a conical frustum whose sides have the angle required; say about 3° from the perpendicular.

**Tool-hold'er.** 1. A tool-handle.

Fig. 6533.




*Hand-Tool Holders.*

Fig. 6533 shows a number of holders having jaws which are opened and closed by an expanding plug or a screw.

*a*, patent lever file-handle.

*b*, patent adjustable self-centering file-handle.

*c*, the same with ferrule removed.

*d*, patent adjustable tool-holder.

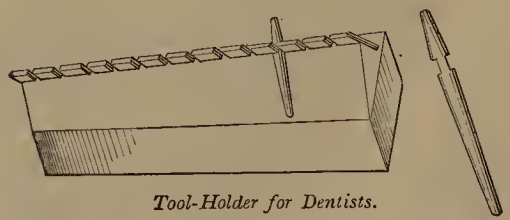
*e*, patent hand-vise.

See also PORTE-AIGUILLE: PORTE-POLISHER; etc.

2. A tool-tray.

Fig. 6534 is a tool-holder for dentists. The tool is detached from its handle by the engagement of a flattened portion with a notch in the tool-rack; this retains it in proper presentation for future attachment to the handle.

Fig. 6534.

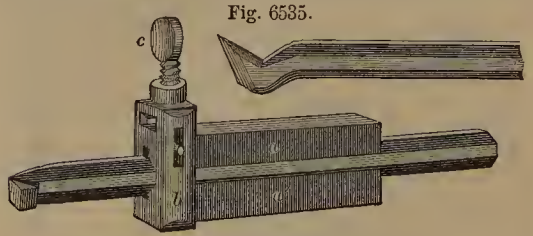


*Tool-Holder for Dentists.*

3. (*Lathe.*) A device for holding lathe-cutters and similar tools firmly.

The two pieces *a a'* pass through the slot in the tool-post, the lower one being fast to the jaws *b*, and the upper one having

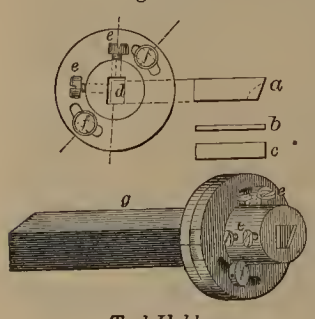
Fig. 6535.




*Lathe Tool-Holder.*

movement in the jaws to accommodate itself to the size of the tool-shank, and being secured by the thumb-screw *c*. See also TOOL-POST; SLIDE-REST: LATHE.

Fig. 6536.



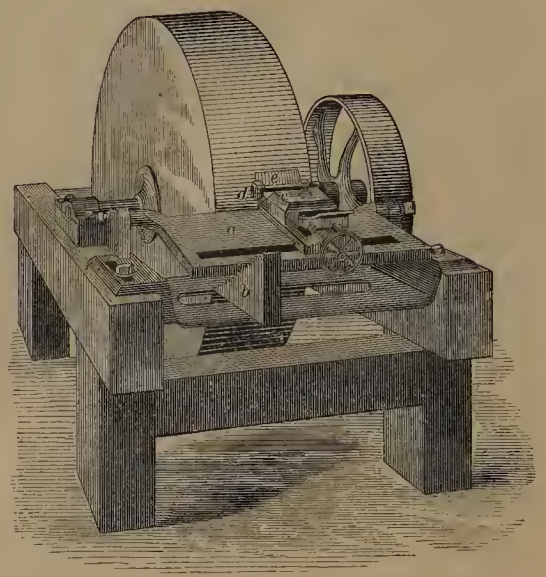

*Tool-Holder.*

Fig 6536 illustrates Holtzapffel's holder for carrying small rectangular blades used for cutting screw-threads; these are alike in hight *a*, but vary in width *b c*, this being half the pitch of the thread; they are inserted in the mortise *d*, and secured by four set-screws *e e*; the screws *f f* passing through circular slots permit the blades to be set to the particular angle of the thread. g is a perspective view of the holder with the tool in position. The list might be increased indefinitely; these are but samples.

4. (*Grinding.*) A device for accurately facing grindstones, and for uniformly holding tools while being ground.

The pivoted plate *a* is adjusted to any required angle by means of the wedge-shaped block *b*, and carries a tool-holder *c*, by which the adjustment of the scraper *d* or a tool to be ground is effected, and it is held firmly while dressing the stone.

Fig. 6537.

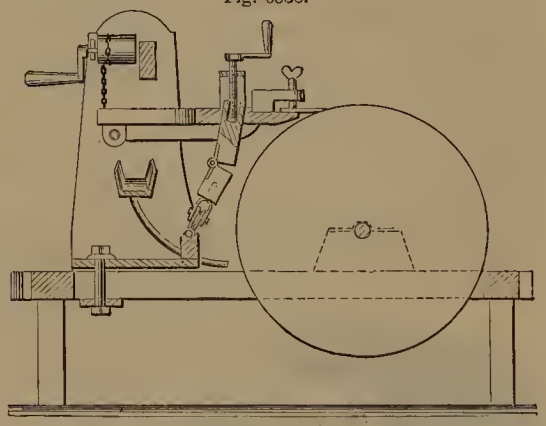


*Tool-Holder and Grindstone-Dresser.*

The tool-holder has a guide fitting a slot in the pivoted plate, so that it may be moved truly parallel to the face of the stone. A fender-plate *e* prevents the scattering of the particles scraped off.

In Fig. 6538, the tool to be ground is secured in the front end of the shoe, by the movement of which on the horizontal rod the tool is drawn across the periphery of the grindstone. Provision is made for raising and lowering the front end of the shoe to adapt the device to the work in hand.

Fig. 6538.



*Tool-Holder for Grindstones.*

In Fig. 6539, a series of clamping jaws hold the articles to be ground. A quick automatic motion is imparted to the holder transversely to the grinding surface of the stone. An intermittent forward motion is given to the holder by means of an arm on the latter placing in and out of gear a bevel-wheel actuating a screw which works in a nut in the holder.

**Tool'ing.** 1. (*Masonry.*) Stone-dressing in which the face shows the parallel marks of the tool in symmetrical order.

2. (*Carving.*) Elaborate carving by chisels and gouges in stone or wood in architecture, joinery, cabinet-work, and furniture.

3. (*Bookbinding.*) Ornamental gilding or embossing by heated tools upon the leather binding of books.

The tools employed are brass stamps, cut into the desired pattern and mounted in handles (Fig. 6540).

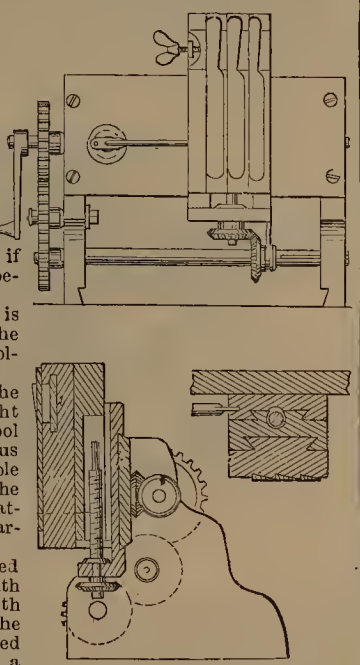
Long lines, plain or figured, running along the sides of the book, are formed by a circular disk of brass, rotating in a handle, the design, if any, being cut on its periphery.

When pressure only is applied, without gold, the work is termed *blind*-tooling.

The workman rests the handle against his right shoulder, holding the tool near the axis; he can thus run the tool the whole length of each side of the cover. The tools are heated at a gas-stove or charcoal-furnace.

*Gold*-tooling is produced by covering the parts with albumen and then with gold-leaf, and pressing the hot tool on the covered parts. On wiping with a hot rag only that part of the gold-leaf is left which was in contact with the hot tool.

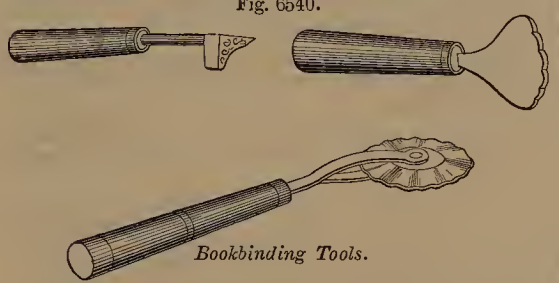
Fig. 6539.



*Machine for Grinding Metallic Articles.*

Lettering is done by means of brass letters, of different sizes, set up in a wooden handle. The words in most common use are often made in one piece, as shown in Fig. 6541.

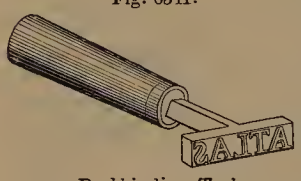
Fig. 6540.



*Bookbinding Tools.*

When the ornaments, lettering, etc. are complete, the book is polished by rubbing with heated irons of various shapes and sizes; one of these is shown in Fig. 6542.

Fig. 6541.

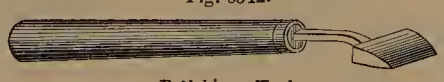



*Bookbinding Tool.*

**Tool-post.** (*Lathe.*) A device on the upper part of a slide-rest by which the cutter is held.

In that shown (Fig. 6543), the end of the tool is inserted in the beveled slot and fixed at the required angle for cutting by the binding-screw *a*; it may be released or readjusted by a very slight movement of this screw.

Fig. 6542.



*Polishing-Tool.*

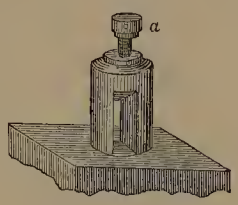
**Tool-rest.** (*Lathe.*) The portion of a lathe to which the tool is attached, and which has usually several adjustments; longitudinally and transversely of the shears, and vertically. See SLIDE-REST, Figs. 5188, 5189; SLIDE-LATHE, Fig. 5187.

In Fig. 6544, the segmental rest is oscillated in the poppet-block to incline the tool, by a screw which engages its intaglio screw-rack.

**Tool-stack.** A *tool-post* or *tool-holder*.

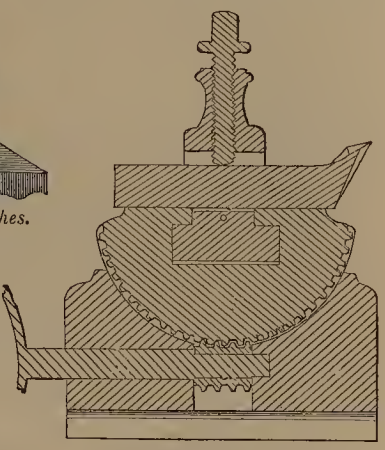
**Tool-stay.** (*Turning.*) The stay is fitted in the lathe-rest, and its slot affords a holder for a drill or internal cutting-tool.

Fig. 6543.




*Tool-Post for Lathes.*

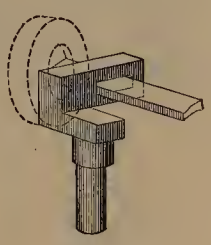
Fig. 6544.



*Lathe Tool-Rest.*

**Tooth.** In a mechanical sense, a term applied to a projecting lug, whose duty is to tear, crumble, cut, or to mash with the object to which it is applied. For instance: the teeth on the cylinder of a *grain-thrasher*, a *corn-sheller*, an *apple-grinder*, on a *harrow* or *clod-crusher*, on a *saw* or *file*, or on a *cog-wheel*. The character of a *tine*, or *prong*, is that of piercing, as in the familiar instance of the *tines* of a fork; as we say, a *two-tined* or *two-pronged* fork.

Fig. 6545.



*Tool-Stay.*

The tooth of a wheel is better called a *cog*.

*Specifically:* 1. A small, narrow, projecting piece, usually one of a set; as,

2. The tooth of a comb, a saw, a file, a card, a rake. See SAW-TOOTH, etc.

3. A *cog* of a wheel.

4. A *tine* or *prong* of a fork.

**Tooth, Ar-ti-fi'cial.**

Hippocrates, about 400 B. C., refers to instruments for the extraction of teeth, and cites a mode of fixing them by gold wire. They were probably natural teeth artificially inserted.

Celsus, about the Christian era, refers to filling carious teeth with lead and other materials. Soon after this we read of false teeth of bone and ivory.

Actius, in the fourth century, describes the filling of carious teeth.

Martial, in one of his epigrams, attributes the whiteness of Lecania's teeth to the fact of her wearing those of some other person.

Mr. Welding of Philadelphia states that he has seen a tooth which had been plugged with gold taken from the alveolus of an Alexandrine mummy.

Blagrave's "Mathematical Jewell," published in the time of Queen Elizabeth, tells us that "Sir John Blagrave caused his teeth to be all drawne out, and after had a set of ivory in agayne."

In Ben Jonson's "Silent Woman," published in 1607, one of the characters says: "A most vile face! and yet she spends me forty pounds a year in mercury and hog's bones. All her teeth were made in the Blackfriars."

Ivory was for many years the favorite material for artificial teeth, that from the hippopotamus being preferred. The teeth of the narwhal, as being somewhat harder, were also used. Volney, Chateaubriand, the elder Pitt, and George Washington also used artificial dentures thus made. See DENTURE.

About 1765 Pierre Lavouse, a workman in the royal porcelain works at Sèvres, France, made rude imitation teeth of porcelain, but the art was not practiced to any considerable extent until about forty years ago, when it began to be utilized in the United States, where it has now developed into a manufacture of no inconsiderable importance.

The principal materials employed are feldspar, silica, and kaolin, with various fluxes for promoting fusion. Coloring materials, as titanium for yellow, platinum sponge for gray, oxide of cobalt for bright blue, and oxide of gold for red, are

also used for tingeing the body of the tooth and its enamel. The variety of shades which may be produced by the use of different colored bodies and enamels is almost infinite; 40 differently colored bodies and 130 standard shades of teeth, classified by numbers, are known in the trade.

The feldspar is heated to a red heat, plunged into water, broken to pieces by the hammer, and foreign matters, such as mica or iron, separated; it is then coarsely pulverized, and afterward ground to an almost impalpable powder. The silex is subjected to the same process, and the colors are also thoroughly ground.

The materials, having been dried and sifted, are taken to the mixing-room, where they are properly proportioned, and again ground, in combination with water, into the various mixtures desired; the body to the consistence of putty, the point enamel to a thick batter, and the outside and gum enamels, of cream.

Small platinum pins, with solid heads and jagged ends, are formed from platinum wire by a machine, and are inserted into the matrices previous to the teeth being formed; these are for the purpose of holding each tooth to its plate.

The molds are of brass, and are made in two parts. The pins are inserted by one workman, and the mold transferred to another, who takes up a small quantity of the point enamel on a spatula and presses it into the matrix; a third workman fills the mold with the body composition, and then closes it. It is now pressed in by machinery and placed in the drying oven.

When sufficiently dry it is taken out and the teeth transferred to clay slides and brought to a cherry-red heat in a furnace. This process is called *biscuiting*. They are now soft, like chalk, and may be cut or filed as desired. Having been arranged into sets, they are next trimmed and smoothed, and receive a coating of enamel, laid on with a brush, and also an enamel which, after heating, assumes the natural color of the gums. Any surplus enamel is then removed, and the teeth are laid carefully on beds of quartz sand, in trays of fire clay, which are then placed in a muffle contained in the furnace and surrounded by a mass of incandescent fuel. After remaining from fifteen to thirty minutes, depending on the state of the fire, the teeth are removed finished, the material having been thoroughly hardened and the various colors brought out by the heat.

Fig. 6546

*Artificial Teeth.*

Artificial teeth are attached to the artificial gum by platinum pins. *a*, incisor tooth; *b*, canine; *c d e*, molars; *f*, pin.

See also DENTURE.

**Tooth-brush.** A brush, usually of bristles, for cleaning teeth. A tooth-brush of spongy rubber is described in Francis's patent, 1869. Sponge also is cited.

**Tooth-cem'ent.** Oxide of zinc mixed with a solution of chloride of zinc, used for filling teeth.

**Toothed Wheel.** A *cog*-wheel. See list under GEARING.

**Tooth'ing.** Bricks left projecting at the end of a wall for the purpose of building on an addition thereto.

**Tooth'ing-plane.** A plane in which the *iron* has a serrated edge and is placed upright. It is used for scoring surfaces which are to be veneered. The scoring helps the *bond* of the glue.

**Tooth-key.** The tourniquet, or lever tooth-drawer.

**Tooth-net.** A large, anchored fishing-net.

**Tooth'pick.** Agathocles was poisoned by a medicated toothpick handed him after dinner, 289 B. C.

The *toth-gare* of the Anglo-Saxons. Made anciently, as now, of silver, wood, quill, and what not.

Magnetic toothpicks were made at the end of the seventeenth century.

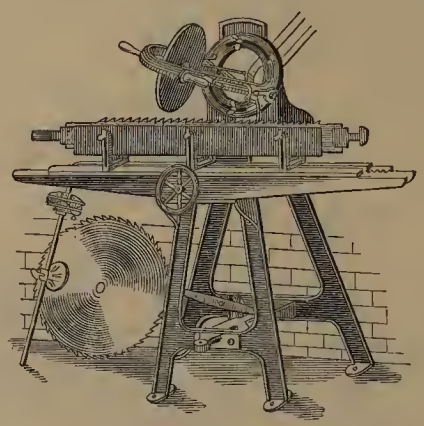
**Tooth-pow'der.** Apuleius recommended charcoal; camphorated chalk is good.

**Tooth-plug'ger.** See DENTAL PLUGGER, page 686; PLUGGER, pages 1749, 1750.

**Tooth-saw.** The dental saw is a fine frame-saw, used for cutting off the natural teeth for the attachment of pivot teeth; for sawing between the teeth; or for sawing off the wires of artificial teeth to detach them from the plate.

**Tooth-sink'ing Ma-chine'.** A machine-tool for making the teeth of saws. That shown in Fig. 6547 is driven by a pulley at the back. The emery-

Fig. 6547.



*Tooth-Sinking Machine.*

wheel is started or stopped by the foot, and is brought down upon the saw-blade by the hand, an adjustable gage limiting its range of motion, so as to have the depth uniform. The saw-bed is fed between each stroke, by means of a hand-wheel pinion and rack.

**Top.** 1. (*Nautical.*) A platform surrounding the head of the lower mast, formed of timbers called cross-trees, which are laid across the *trestle*-trees, the latter being supported by cheeks secured to the sides of the mast below the head.

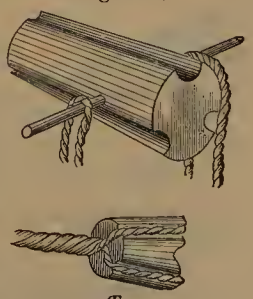
The top serves to form an extended base for securing the lower ends of the topmast shrouds, and is also a place of rest for the men aloft.

It is occupied by riflemen during a naval engagement at close quarters. Nelson was killed by a musket-ball from the top of the French vessel with which the "Victory" was engaged.

2. (*Rope-making.*) A plug with three grooves used to regulate the twist of a rope when three strands are being *laid up* (twisted).

Each strand occupies one of the grooves, and the *top* is held by a diametrical pin and two pieces of soft rope called *tails*. The three stands are attached to the hook of the *breast-board* and to the hook of the *sledge*; rotation is given to the cluster from the former; the top is forced as far as possible toward the *sledge-hook*, so as to allow the twist to commence at that end, the top giving way as the twist crowds it forward to the head end of the yarns. The process of twisting shortens the strands, and the sledge moves forward also, at which time the man at the sledge commences to rotate the hook at his end in a direction contrary to that by which the strands are twisted together.

Fig. 6548.



*Top.*

The pins by which the block is held in the angles formed by the twisting rope are called *woolders;* the ropes are *tails*. These are wrapped around the rope so as to oppose, by their friction, the advance of the top.

The motion of the *top* is regulated to insure equal hardness to the rope.

3. (*Fiber.*) A narrow bundle of slivers of long-stapled wool, containing about 1½ pounds. The slivers are made by a pair of combs. See WORSTED.

4. The uppermost piece in the back of a chair. A *slat-top* is mortised at its ends into the sides of the *posts*. A *round-back* is mortised at its lower edge to the tops of the posts. A *rim-back* is one in which

the back and elbows are formed of a continuous piece.

5. That portion of a cut gem which is between the *girdle*, or extreme margin, and the *table* or flat face.

6. A well-known toy, which has attained its greatest excellence among the Japanese.

From the steadiness of its motion and its strictly perpendicular position when at speed, it has been suggested to place upon it a mirror at right angles to the axis, to act as an artificial horizon at sea.

**Top and But.** (*Shipbuilding.*) A mode of working plank which does not maintain its width from end to end. The top of one plank and the but of the other are worked together so that the two layers make a double breadth of even width.

Each plank has one edge straight, the other edge having a long and a short slope; the long slope being toward the top, and the short one toward the but of the tree from which the planks are sawn.

**Top-ar'mor.** (*Nautical.*) A top railing with posts and netting on the top-sides.

**Top-block.** 1. (*Nautical.*) A single iron-bound hook-block; it hooks to an eye-bolt in the cap. The top pendants are rove through the top-blocks when swaying up or lowering down the topmasts.

Fig. 6549.

*Top-Block.*

2. (*Vehicle.*) A projecting piece on which the bows of the carriage top rest when down. See Fig. 3971.

**Top-chain.** (*Nautical.*) One of the chains by which the lower yard is sustained if the slings be shot away.

**Top-cloth.** Tarred canvas to cover hammocks when stored away on the top, in action.

**Top-flat,** or **Top-card.** A slat or narrow board having card-teeth on its under surface, placed above the large central cylinder of a carding-machine so as to arrest knots and act coincidently with the cylinder in bringing the fibers into parallelism, preparatory to *drawing*, *doubling*, and *spinning*. See CARDING-MACHINE.

**Top-gal'lant.** The mast, rigging, and sail next above the topmast, as, maintop-gallant mast, fore top-gallant shrouds, or braces; mizzen top-gallant sail. See SHIP.

**Top-ham'per.** (*Nautical.*) The masts, spars, and rigging of a vessel. The clutter of a deck. Boats *inboard* and on their davits. Horse and gang casks, anchors, cables, and coiled or belayed ropes of the running rigging. Sometimes applied to unnecessary weight above deck.

**Top'i-cal Col'or-ing.** A term used in calico-printing to indicate that the color or mordant is applied to specific portions of the cloth forming the pattern, in contradistinction to the application of color to the cloth in a dye-bath.

**Top'it.** The top-piece of a train of rods in well-boring. See WELL-BORING.

**Top'mast.** (*Nautical.*) The mast above the lower mast; the second from the deck, and below the top-gallant mast. See SHIP; SAIL.

**Top-mi'nor.** (*Rope-making.*) *Top-minors* are holes through which the individual strands are drawn on the way to the twisting-machine. See ROPE.

**Top'o-graph'i-cal Sur-vey'.** A mapping of a country with absolute accuracy and minuteness of detail, made with elaborate instruments and repeated careful observations, as distinguished from a *reconnoissance*, or hurried survey made with portable instruments in a hurried manner.

**Top'per.** An equilateral, *single-cut* file, or *float*, used by comb-makers. See COMB.

**Top'ping.** 1. Reducing to an exact level the points of the teeth of a saw.

2. (*Nautical.*) Lifting one end of a yard higher than the other end.

**Top'ping-lift.** (*Nautical.*) A tackle for raising the outer end of a gaff or boom.

**Top-rope.** (*Nautical.*) A rope to sway up a topmast.

**Top'sail-schoon'er.** A vessel otherwise schooner-rigged, but carrying a square sail on the foremast.

**Top-saw.** The upper saw of a pair in a circular saw-mill. In large logs, the lower and larger saw does not penetrate to the upper edge. The *top* or supplemental saw cuts through the upper surface and down to the kerf of the lower saw. The top-saw is a little in advance or rear of the under one, to make the kerf complete without collision of the teeth of the respective saws. See *d*, Fig. 1298.

**Top'side-line.** (*Shipbuilding.*) A sheer line drawn above the top timber at the upper side of the gunwale.

**Top-sides.** (*Shipwrighting.*) The upper part of the ship's sides. These, under Feather's system, are of iron; the upper frames terminating in broad forks or saddles, which sit upon and are fastened to the wooden parts of the sides.

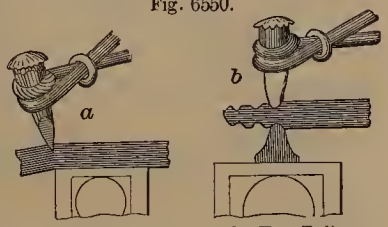
**Top-tack'le.** (*Nautical.*) Used in swaying up a topmast.

**Top-tim'ber.** (*Shipbuilding.*) In the ribs of a ship's side, the timber next above the futtocks. See FRAME.

**Top-tim'ber Line,** or **Top-breadth.** (*Shipbuilding.*) A line in the sheer plan drawn to the sheer of the ship fore and aft, at the hight of the under side of the gunwale amidships.

**Top-tool.** A blacksmith's tool which has a flexible handle, such as a withe of hazel, and used above the work, being struck by a hammer. In contradistinction to the bottom tools, which are below the work, and have a tang which fits a square hole in the anvil.

Fig. 6550.

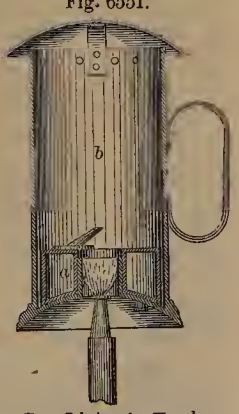



*a. Top-Tool.* *b. Top-Fuller.*

A *top-fuller* is a tool with a narrow round edge, like the pane of a hammer, and having the ordinary hazel-rod handle.

**Torch.** The torches of the ancients (*funalia*, because made of rope) were conical, and bound at intervals. Flambeaux of waxed cords, straw, or papyrus-leaves were also used; also *fasces* of wooden rods, fir, oak, ash, hazel, cornel. Tubes filled with combustible matter. The *palearia* of the thirteenth century were torches of straw; the *thyrsus*, thread covered with wax rolled round a staff.

Fig. 6551.

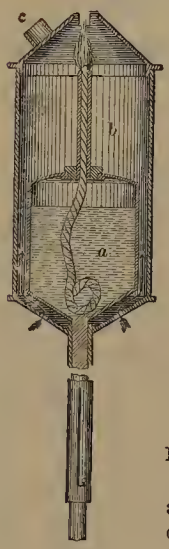



*Gas-Lighter's Torch.*

Fig. 6551 is a gas-lighting torch. A spirit-lamp *a* is set in a case *b*. This case has an orifice at the bottom, which is placed over the burner in order to light the gas-jet. The lamp can be trimmed through a door in the case, and is protected from the weather.

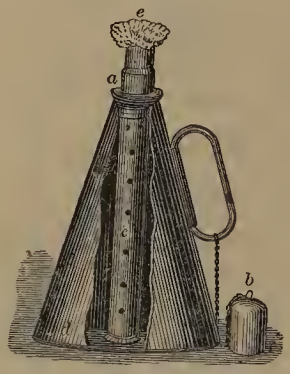
In the torch, Fig. 6552, the lamp *a* is inclosed within a case *b* for protection, but the wick tube may be protruded through an opening at the top for the purpose of lighting a lamp, the handle having motion in a sleeve at the bottom of the case. *c* is a wrench for opening the gas-cocks, and a slot across the top of the case is for the same purpose.

Fig. 6552.




*Torch.*

Fig. 6553.




*Plumber's Torch.*

Fig. 6553 is a plumber's torch. See also ELECTROPHORUS.

2. Torches for military purposes are made of a number of strands of twine, slightly twisted, or of old rope, covered with a composition to give light, consisting of tallow, wax, and rosin, or equivalent ingredients.

**Tor'cu-lar.** (*Surgery.*) A tourniquet or bandage.

**Tor-ment'or.** (*Husbandry.*) A heavy harrow with cutting teeth, used in English husbandry for breaking down stiff clods, or tearing up the surface-turf. It resembles a harrow, but runs on wheels, and each tine is a hoe or cutting-share.

**Tor-pe'do.** A movable chamber or mine charged with an explosive which is fired by contact or by fuse. They are here divided into

1. Nautical.
2. Military.
3. Oil-well.
4. Railway.
5. Fishing.
6. Toy.

1. (*Nautical.*) Torpedoes are of four classes, —

*a*. *Drifting.* *c*. *Boom.*
*b*. *Anchored.* *d*. *Maneuvered.*

The drifting and anchored preceded the boom and maneuvered, and are adapted for circumstances and positions where (*a*) they may be allowed to drift with the stream or tide against a vessel in a river or channel or at anchor; or (*b*) may be placed in the path of a vessel, or in the line of attack.

The maneuvered class is adapted to be navigated usually beneath the surface of the water, its course and depth being determined and regulated by various devices to bring it in contact with the ship against which it is directed. The *torpedo* perishes in the explosion; the *torpedo*-boat, on the contrary, carries a torpedo, and either explodes it against the enemy's vessel in such a manner as not itself to suffer in the contact, or launches it against the vessel after attaining such a degree of proximity as to insure the aim and power of navigation of the torpedo. See TORPEDO-BOAT.

Several terms used in practice are rather general than accurately technical, as they denote whole classes. Such are, —

*Magnetic* torpedo, one exploded by electro-magnetism, by spark, wire, or ignited pencil-line in a fuse; in contradistinction to one fired by contact, clock-work, etc.

*Submarine* torpedo, one placed beneath the surface of the water.

*Can*-torpedo, one in a metallic caisson.

*Laniard*-torpedo, one pulled off by a laniard, etc.

The torpedo is so named from a species of ray found in the Mediterranean, which has the power of imparting an electric shock when touched. The *Gymnotus electricus*, a fresh-water eel of South America, has a similar power. The torpedo-ray has long been known. Theophrastus, in his "Treatise on Poisonous Animals," says that "the torpedo can send the power which proceeds from it through wood and through harpoons, so as to produce torpor in those who have them in their hands." Athenæus, in the "Deipnosophists," says: "Clearchus the Solensian has explained the cause of this in his 'Treatise on Torpor,' but since his explanation is rather a long one, I do not recollect his exact words." The author of the "Banquet of the Learned" goes on to say: —

"Plato, the philosopher, says in the 'Meno,' 'you seem very much to resemble the sea-torpedo, for that fish causes any one who comes near it to become torpid'; and an allusion to the name occurs also in Homer, where he says,—

"'His hand was torpid at the wrist.'

"'The torpedo,' says Aristotle, 'is one of the cartilaginous and viviparous fishes; and, to provide itself with food, it hunts after little fish, touching them and causing them all to become torpid and motionless.'

"Archestrus says in his 'Demetrius,' —

"'Then I took a torpedo, calculating
If my wife touched it with her tender fingers
That they would get no hurt.'"

For an account of the Gymnotus, see Humboldt's "Cosmos."

In the early instances, floating mines were used in breaking booms, bridges, or other obstructions to navigation, as well as in breaking a cordon of ships or destroying a fleet in port.

In 1585 four floating mines were sent from Antwerp by Zambelli, against a bridge across the Scheldt, erected by the Duke of Parma. Each flat-boat of about eighty tons' burden was stowed with 7,000 pounds of powder confined by mason-work and heavy stones. The mines were to be exploded by a match-rope and by clock-work. One was successful, and made a breach of 200 feet in the bridge, doing immense damage in the vicinity.

September 30, 1628, the English employed floating tin caissons of powder against the French at Rochelle. One exploded against a vessel without seriously damaging it. The others were intercepted.

"In the afternoon come the German, Dr. Knuffler, to discourse with us about his engine to blow up ships. We doubted not the matter of fact, it being tried in Cromwell's time, but the safety of carrying them in ships." — PEPYS's *Diary*, 1662.

In 1688 an immense floating bomb was prepared by the French against the port of Algiers, but was not used.

In 1693 - 95 similar contrivances were used by the English in besieging St. Malo, Dieppe, and Dunkirk, without serious damage.

In 1770 the Russians burned the Turkish fleet in the port of Tchesme, and destroyed the fortifications by the shock of the explosion.

In 1804 the loaded catamarans of Fulton were used by the English against the French fleet off Boulogne. But little damage was done.

The experiments were repeated again and again against Le Forte Rouge at Calais, 1804 (Fulton blew up the brig "Dorothea" in Walmer Roads, October, 1805. See Fulton's "Torpedo War," and "Torpedoes, their Invention and Use," by W. R. King, U. S. A., 1866, Plates XVIII., XIX.); Rochefort, 1809; the pontoon bridges of the French on the Danube, at Essling; in 1813, by the Austrians in attempting to destroy the bridges across the Elbe at Kœnigstein.

About 1843 Colonel S. Colt constructed a torpedo with which he blew up a ship in the Eastern Brauch of the Potomac River, near the Washington Navy Yard; it is believed that the most important feature of this consisted in the application of electro-magnetism as a means of exploding the contained powder.

Torpedoes were extensively employed by the Russians during the Crimean war as a defense for the harbor of Cronstadt. These were suspended from buoys to which they were connected by pipes inclosing at their upper part a small glass tube containing sulphuric acid; on the buoy being touched by a passing vessel, the tube would be broken and the sulphuric acid come in contact with chlorate of potash in the lower part of the pipe, causing its immediate inflammation and consequent explosion of the gunpowder in the magazine.

The experiment of the "Louisiana" before Fort Fisher in 1864 is one of the latest instances. Two hundred and fifteen tons of powder were stowed on board. A tier of barrels, with the upper heads removed, were covered by 60-pound canvas bags. A Gomez fuse was woven through the mass. Three modes of explosion were adopted, — clock-work and percussion, candles, slow-match. The vessel was towed within 851 yards of the works, and exploded in one hour and fifty-two minutes, without doing any damage whatever to the fort. See *infra*, Fig. 6560.

*a*. The *drifting* torpedo is of various forms, and in its mode of action it is carried against the enemy's works or vessels by the current of the river, the set of the tide, or the drift of the wind.

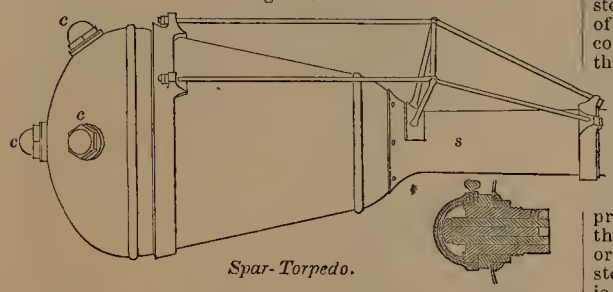
They may be divided into *can* or *buoy* torpedoes, according to shape; *laniard*-torpedoes, which are pulled off by a cord; *hydrogen*-torpedoes, which, when the can strikes a vessel, turn a stream of hydrogen on to a piece of spongy platinum and ex-

plode the charge; *horological* torpedoes, exploded by clock-work after the expiration of a given time.

The *Boule de Verdun* is the name given to a crawling torpedo which was to have been launched at Verdun with the purpose of destroying a bridge which the Prussians had thrown across the Meuse, about three miles below the city. It was a nearly spherical chamber, about 40 inches in diameter, and contained a clock-work mechanism for pulling the trigger of a double-barreled pistol which ignited the primary powder. It was based upon the principle that a spherical body of a weight slightly greater than the displaced water, and having its center of gravity and magnitude coincident, will seek and keep the deepest portion and current of the river. It was not used, as Verdun capitulated just before it was to be launched.

A drifting spar-torpedo intended to overcome obstructing chains or booms was invented by Lewis, of the British Royal

Fig. 6554.




*Spar-Torpedo.*

Engineers. It had a spar weighted to float nearly vertically, and when the upper end met with an obstruction, the lower end passed underneath, and, the weight being dropped by the action, the lower end, carrying the torpedo, rose rapidly and struck against the vessel's bottom.

*b. Anchored* torpedoes are attached to mooring piles or anchors. They are firmly connected to submerged structures, or by a cable or swaying boom which allows them some lateral play.

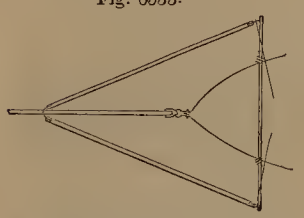
*c. Spar*-torpedoes. The spar-torpedo is carried on the end of a spar rigged overboard from the bows of a vessel, as seen in Figs. 6555 and 6556, or attached to the prow.

It is of sheet-copper with brazed joints. It has a sensitive primer, with a cylindro-conical head communicating with the magazine of the torpedo. The head is in contact with and protected from the water by a thin hemispherical cap of soft, well-annealed copper. Fig. 6554 shows the torpedo, the smaller figure being an enlarged view of the exploding arrangement.

The charge is usually fired by contact, but sometimes by electricity. The system was used in the extensive torpedo practice in Florida Bay, 1874.

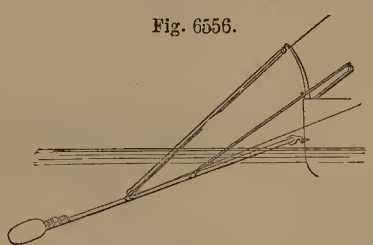
Figs. 6555, 6556, show it as rigged on the "Pinta."

Fig. 6555.



*Spar-Torpedo Fittings, "Pinta" (Plan).*

Fig. 6556.



*Spar-Torpedo, "Pinta" (Side View).*

The Wood and Lay spar torpedo was used in the United States Navy, notably by Lieutenant Cushing in destroying the Confederate ram "Albemarle" at Plymouth, N. C., in 1864. It was attached to a spar by means of the lug *b*; run beneath the enemy's vessel; detached from the spar by a device for that purpose; allowed to rise against the vessel by its flotative power, when the lanyard was withdrawn, allowing the ball *a* to fall upon the cap *c* and explode it and the charge.

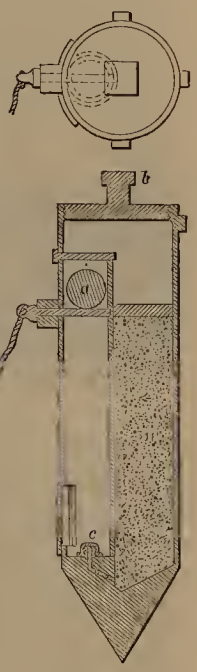
The *otter*-torpedo, so called, is towed by a line from a boom rigged out athwart ship.

*d. Maneuvered* torpedo.

The *fish*-torpedo is so named from a certain resemblance in form, and from its having an independent and automatic swimming action after being launched in the direction of the object of attack.

It is also known as the *Whitehead* torpedo, and as the *Luppis-Whitehead* torpedo, from the names of two persons intimately concerned in its suggestion and invention.

Fig. 6557.




*Wood and Lay Torpedo.*

The body of the *Ericsson* torpedo consists of a box of thin steel plates, 8 feet 6 inches long, 30 inches deep, and 20 inches wide. The explosive is placed at the bow. The propellers are two-bladed, 3 feet 2 inches in diameter, with a pitch of 5 feet. Both revolve around a common center in opposite directions. The motive power is a small double-cylinder oscillating-engine, driven by compressed air, which is supplied by a 25 horse-power steam-engine on shore, and transmitted through a tubular cable, connected just abaft the stern, as shown in Fig. 6558. The air-pressure also governs an equipoise rudder, secured under the bottom and near the bow. The steering is effected by applying the force of the air against the tiller on one side, counteracted by the tension of a spring on the opposite side.

The submersion is regulated by two horizontal rudders turning on a transverse axle which projects from each side near the bow. These wings or rudders are so contrived and governed that they keep the torpedo at a depth of from 7 feet to 12 feet below the surface, and are provided with automatic devices, so that the latter limit cannot be exceeded. In order to note the course of craft, a light steel mast is secured to the deck. This is 12 feet in length, and terminates above in a wooden ball, the forward side of which is painted sea-green, so as not to be perceptible to the enemy, and the rear white, so as to be easily distinguished above the water by those dispatching the torpedo. Openings are made in the engine-compartment, through which the water enters, completely filling the interior space. The machinery is made of bronze with boxwood bearings, so that the water serves as a lubricant to every portion, thus doing away with stuffing-boxes at the rudders. The apparatus is launched overboard by means of swinging-davits, as shown in the figure. The bow-piece containing the charge is detachable.

The *Lay* torpedo used at Newport is a cigar-shaped vessel, 30 feet long and 3 feet wide, formed of water and air-tight iron plates, in three compartments. One of these is to contain the motive power, — compressed carbonic-acid gas. Another holds the machinery, which is controlled by an electric battery on shore by means of two wires, one of these governing the throttle and the other the steering-apparatus. In the third compartment is stored 500 pounds of powder or other explosive, and in the forward portion of the vessel explosive shells are also arranged to be fired by an electric spark passing through a third wire. These wires are embedded in a cable which is paid out as the vessel moves on. The shells are exploded without injury to the torpedo, but of course the explosion of the magazine causes its destruction.

Of late years the subject of harbor defense by means of torpedoes used offensively against an attacking fleet, has attracted great attention, and a naval torpedo-station has been established at Goat Island, Newport Harbor, for the purpose of instruction in their use and management on board vessels specially constructed for this object. See TORPEDO-BOAT.

No less than 18 United States vessels were destroyed through the agency of torpedoes during the late war.

One was blown up, but not destroyed.

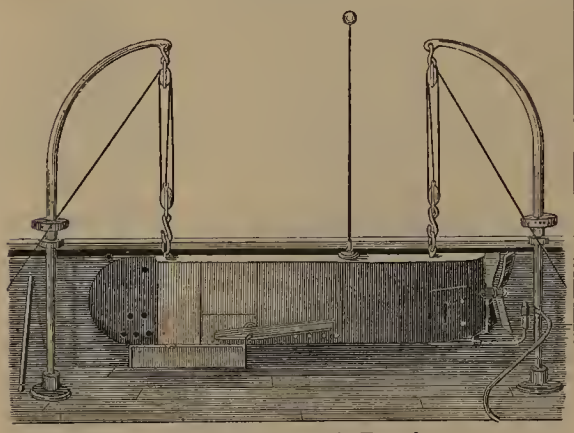
Of these were the monitors "Patapsco" and "Tecumseh," at Charleston and Mobile Bay respectively; the iron-clads "Cairo" and "Baron de Kalb," in the Yazoo River; the iron-clads "Milwaukee" and "Osage," in the Blakely River.

In the case of stationary submarine torpedoes, the operator must know the position of each, and be provided with means for determining when a vessel approaches within its range. For this purpose instruments for measuring angles are employed, or the torpedo itself is provided with devices for indicating the proximity of a ship.

Experiments are now being made at Portsmouth, England, on torpedoes of the latter class. A network of these is connected by insulated wires with a galvanic battery on shore; the wires of one set conveying the message to the operator, and those of the other serving to explode any selected torpedo by touching a key.

In other cases the firing circuit is closed automatically by the action of the signaling apparatus. The firing is effected by a strand of platinum wire, made red hot by the passage of a current when the circuit is completed. These experiments are said to prove that comparatively large charges cannot be exploded without compromising other charges within their effec-

Fig. 6558.



*The Ericsson Pneumatic Torpedo.*

tive area. The question remains to be decided whether it will be more practically advantageous to employ comparatively small torpedoes placed closely together, or those of larger size placed at greater intervals apart.

Another English writer remarks that during the civil war in America, the Federal fleet was in no instance successful in passing a well-arranged system of fortifications where torpedoes were used, unless the forts were first reduced from the land; and in no instance did the navy fail to accomplish its object where torpedoes were not used.

As an instance of the fallibility of torpedoes, it was found after the capture of Charleston that the "Ironsides," the most powerful vessel in the Federal fleet, had lain for three months over a torpedo containing 3,000 pounds of powder. This was to have been exploded by electricity, but failed to go off.

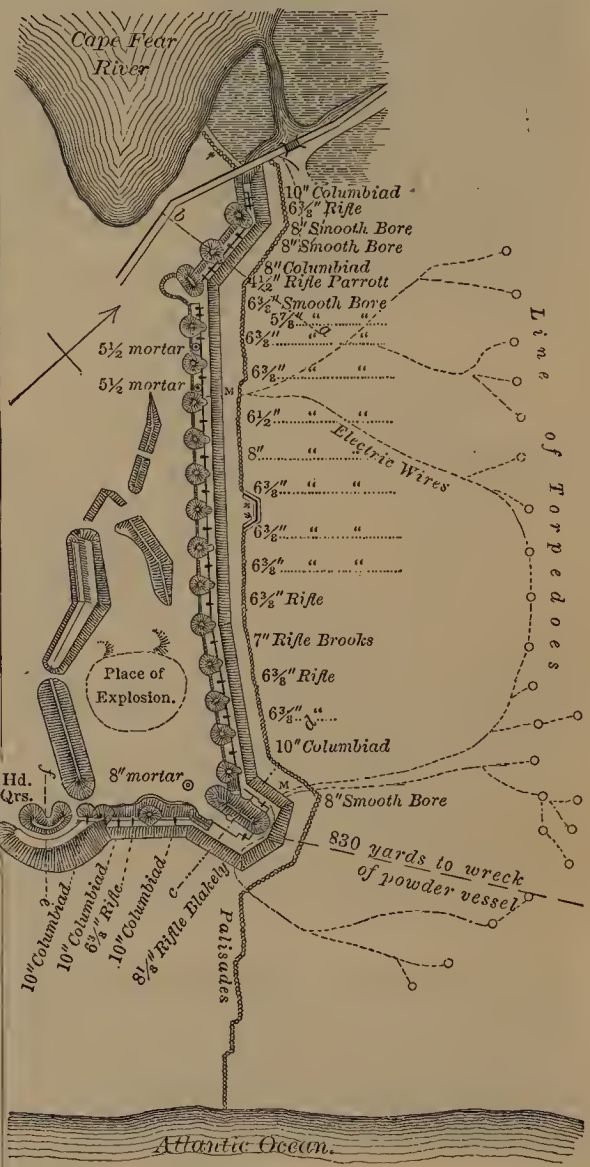
An instance of the moral effect of torpedoes was shown in the Franco-German war, where the French navy was completely paralyzed by the presence of torpedoes thickly studded along the German coast, and not a single engagement between the fleet in German waters and the sea-coast defenses is recorded.

Published information on the subject of the torpedo trials may be found in the "Report of the Austrian Commission," 1868; "Army and Navy Journal," 1874; "Revue Maritime," September, 1872, January, 1873; Captain Harvey's "Treatise on the Management of the Sea-Torpedo," London, 1871; Sarrepont's "Les Torpilles," etc.

2. (*Military.*) A mine or countermine to destroy a work, a storming column, or a working party. In this sense a *petard* may be considered as a torpedo. Torpedoes for land defense are usually shells of small caliber, 6 and 12 pounders, provided with a percussion or friction device which causes an explosion when the ground over the torpedo is stepped on. Sometimes several are laid in a row, and a piece of board placed over them to increase the chances of explosion.

At Fort Fisher, larger torpedoes, connected in sets and designed to be fired by electricity, were arranged on the land face

Fig. 6560.



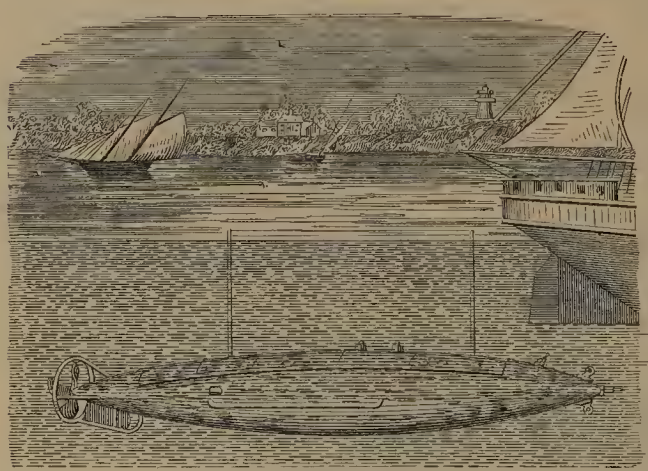

*Plan of Fort Fisher, N. C., showing the Part extending across the Isthmus, and the Face protected by Torpedoes.*

of the work. The wires leading to the majority of these were cut by fragments of shell during the bombardment, probably preventing considerable loss of life during the assault. Torpedoes buried in the ground and fired by a similar arrangement when trodden upon, and others connected by wires with electric batteries, were used in the defense of Sebastopol.

Fig. 6560 shows the northeast face of Fort Fisher, N. C., with the line of torpedoes, twenty-four in number, which were connected with the fort by three sets of double wires, each apparently intended to fire five or more torpedoes. The torpedoes were of three kinds: shells, 13″ diameter; boiler-iron cylinders, 13″ diameter and 18″ long; buoy-shaped sheet-iron cylinders of about the same capacity as the cylinders. Before the storming of the fort shells had cut a number of the wires leading from the work, saving the attacking party from much loss and demoralization.

*Ground*-torpedoes, buried beneath the surface to explode when trodden upon; *bridge*-torpedoes (Haupt's), to rend the timbers or arches of bridges in demolishing them; and *railway*-torpedoes, to blow up a track when a train passes, are all effective military devices.

Fig. 6559.



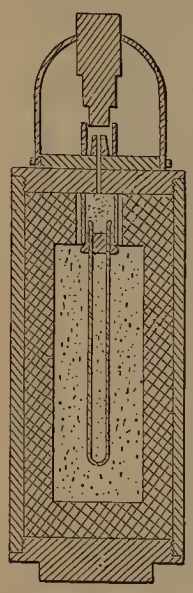
*Lay-Torpedo.*

3. Torpedoes for opening the fissures of oil-wells have been patented by Colonel E. A. L. Roberts and others, and their use has restored productiveness to many wells. In some cases the wells have become choked by paraffine or

other concretion, some perhaps by sediment; in others it is probable that an explosion has opened fissures leading to other pockets or veins of oil.

Some torpedoes of this kind are exploded by a time-fuse, which is let down with the instrument. Others are exploded by a gunlock and wire from above, or by a plunger; but the best and most usual mode of igniting the charge seems to be an electric connection.

Fig 6561.



*Roberts's Torpedo for Oil-Wells.*

Fig. 6561 illustrates a torpedo in which a powder-chamber is surrounded by nitro-glycerine, and a quick-match passes from the powder to the priming-chamber, which communicates through a tube with the fulminate, which is exploded by a hammer. An electric connection not only enables the operator to explode the charge at will, but other packing than water may be used to confine the explosion. A bag of flaxseed is often used for this purpose, which is lowered into the well dry, and, becoming saturated, swells and completely closes the aperture. The bag may be cut or torn open and withdrawn.

In an explosion in an oil-well in the petroleum region, where the boring was over 800 feet deep, two cartridges were prepared, the one 25 inches in length, the other 35 inches, and each 5 inches in diameter. These were connected by a short copper wire, 30 feet in length, so as to adjust the two charges immediately opposite to several mud-veins which were known to be that distance apart, the heaviest charge of 30 pounds nitro-glycerine being at the lower vein, 783 feet deep, the lighter charge at the upper vein. Twelve exploders were inserted in the largest cartridge, and eight in the other, forming a train of twenty exploders, which, by means of insulated wire, were connected about 250 feet from the well with an electric battery.

Everything being arranged, the order was given to fire. In an instant the discharge took place, and a report like a cannon fired from a distance, accompanied by a very perceptible vibration of the earth around, was noticed by those present. The operator and an assistant immediately pulled on the wire, thereby endeavoring to prevent entanglement. When about fifty feet of the wire had been drawn out a reaction ensued, dragging the parties who were pulling at the wire toward the well for a distance of ten feet, to their surprise and great wonderment; this arose from the column of water lifted by the explosion and its return and fall.

4. (*Railway.*) A cartridge placed on a rail to be exploded by a passing train, and thereby signal "caution" or "danger" to the engineer.

5. In the Rocky Mountain regions, some sporting gentry have adapted torpedoes to trout-fishing.

They take a cartridge of Giant powder, weighing about a quarter of a pound, insert into it a piece of fuse, properly capped, about six inches in length; then, lighting the fuse, the cartridge is thrown into any deep hole supposed to contain trout or any other fish. After the cartridge has been thrown into the water, smoke and bubbles of gas are seen to rise to the surface, then in a few moments comes the explosion, — a dull, heavy report. The surface of the water is seen to bulge up, and the ground can be felt to shake for fifteen to twenty feet back from the water.

Immediately after the explosion, all the fish that happen to be within a circle of twenty-five or thirty feet of the spot where the cartridge fell, come to the surface, either killed outright or so badly stunned that it is some minutes before they recover.

6. An explosive toy, consisting of a small quantity of fulminating-powder and fine gravel, wrapped in thin paper. It explodes with a sharp detonation when thrown upon any hard substance.

**Tor-pe'do-an'chor.** An anchor or fastening to hold a submarine torpedo to its selected bed. A serviceable form is that of a ship's anchor, to which the torpedo is attached by a chain with a universal joint.

**Tor-pe'do-boat.** A vessel carrying a *torpedo*, and either exploding it against the side of another vessel beneath the water-line, or launching it against the enemy's vessel when it may be trusted to reach its destination by the force of the impulse, or by a motor on board.

The *torpedoes* are carried on the ends of spars rigged forward, or are towed by booms, or are cigar-shaped vessels known as *fish*-torpedoes, which may be considered self-navigated projectiles. See TORPEDO.

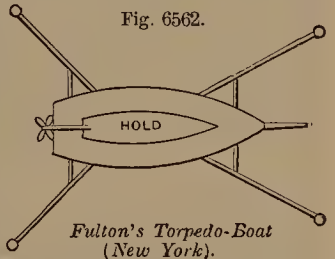
The first *torpedo*-vessel was perhaps the "American Turtle" of David Bushnell, of Connecticut, in 1776. His was a submarine vessel having a torpedo in tow.

It was composed of two shells of sufficient capacity, when joined together and made water-tight, to contain the operator, together with sufficient air to enable him to remain under water for half an hour. He caused the boat to rise or sink by pumping the water from or allowing it to enter a chamber beneath him, at the same time lowering or raising a block of 200 pounds of lead which might be made to touch bottom. He propelled the boat by means of an oar, from a compartment in the fore part, and at its stern a magazine containing powder was attached; this was fired by a lock operated by clock-work in the magazine, which was set in motion at the time of its detachment from the boat, and was calculated to run a sufficient time to allow the operator to reach a place of safety previous to the explosion. With this apparatus he succeeded in frightening the crew of the British 64-gun ship "Eagle," in New York Harbor, and afterward blew up a schooner at New London.

The celebrated Fulton, between the years 1800 and 1807, devoted considerable attention to torpedoes and torpedo-boats, and in 1810 published a work on the subject.

While in France he constructed a boat which, when at the surface, was propelled by a sail, and resembled an ordinary boat; the mast could be struck, and the boat, with its contents, submerged to the depth of several fathoms, and propelled by machinery, at the rate of about four miles an hour, in any direction desired. This invention at first met the approval of Napoleon, who, however, afterward appears either to have lost faith or grown tired of it, as the boat was never brought to any farther practical test.

Fig. 6562.




*Fulton's Torpedo-Boat (New York).*

After the return of Fulton to America, he continued the experiments, without, however, much success. Fig. 6562 shows a boat he devised of 300 tons burden, with sides 6 feet thick, designed to be cannon-proof, and musket-proof decks 6 inches thick. She was to be propelled by a scull-wheel, and was intended to carry two torpedoes on each side, fixed on the ends of spars 96 feet long, supported by guys from the mast-head.

During the late civil war a number of these submarine "infernal machines" were constructed by each party.

The first of these attacks was made off Charleston, against the United States war-vessel "Ironsides," by a cigar-shaped boat, under the command of Lieutenant Cassell, with a crew of three men, carrying a torpedo containing 60 pounds of powder at the end of a spar. Not knowing the action of the explosion, and thinking that their boat would probably be sunk by it, her crew jumped overboard before ramming. The explosion, though severe, failed to make any hole in the bottom of the "Ironsides"; the boat was also uninjured, and was found drifting, half full of water, by her engineer, who climbed into her, made up his fires, and steamed back safely to Charleston.

The submarine torpedo-boat which sunk the United States steamer "Housatonic," of 1,240 tons, and 13 guns, off Charleston, the largest vessel thus destroyed during the war, was 35 feet long, made of boiler-iron, and could be submerged to any desired depth, or propelled upon the surface. She was designed to pass under the bottom of a vessel lying at anchor, and drag a floating torpedo, which should explode on striking the vessel, and could remain submerged for half an hour without inconvenience to her crew, which consisted of nine men, eight to work the propeller and one to steer. The following is her history in brief: She was first sunk by the swell of a passing steamer, drowning all hands, except her commander. After being raised she again capsized and sunk, her commander and two others alone escaping. Being again raised, she made an experimental trip, under one of her constructors, and, while submerged to a great depth, became unmanageable from some unknown cause, and remained for many days, with her crew of nine dead men, at the bottom of Cooper River. Her last achievement was the destruction of the "Housatonic," when she and her crew disappeared forever from all human knowledge.

Of late, however, it is not considered as an absolute prerequisite to an efficient torpedo-boat that she should be capable of being entirely submerged when making an attack. Admiral Porter's system provides vessels of sufficient power to resist the fire of an enemy, and attack openly when necessary. See Fig. 6563.

The destruction of the rebel ram "Albemarle," at Plymouth, N. C., October 27, 1864, was accomplished by the use of one of Wood and Lay's torpedoes (see TORPEDO, Fig. 6557), modified for use by a ship's launch.

Fig. 6563.

*Porter Torpedo-Boat.*

The steam-launch was run up under cover of night, and succeeded in eluding the picket-boats of the enemy. The "Albemarle" was discovered lying fast to the wharf, with logs around her, about 30 feet from her side. As the launch approached she was fired on from the shore, but continued her course straight for the ram. Striking the logs, they were driven inward some feet. "The torpedo-boom was then lowered," says Lieutenant Cushing, "and, by a vigorous pull, I succeeded in driving the torpedo under the overhang, and exploding it at the same time the 'Albemarle's' gun was fired. A shot seemed to go crashing through my boat, and a dense mass of water rushed in from the torpedo, filling the launch and completely disabling her." The "Albemarle" sunk at her moorings. Lieutenant Cushing and one of his crew escaped by swimming.

Just before the close of the war an attack was made, in the James River, on the merchant-vessels which had brought supplies to Grant's army, by the Confederate fleet of three iron-clad rams and seven gunboats, all armed with torpedoes, fixed on the ends of spars, 30 or 40 feet long, which projected from their bows, and could be raised or lowered by a tackle. This fleet was stopped by a boom, and two of the iron-clads got aground, where they remained all night, under fire from the banks; but although their torpedoes were completely riddled with rifle-shot, not one was exploded by the striking of the fuses.

The Porter torpedo (Fig. 6563) is an iron vessel 174 feet long, 28 feet broad, and 13 feet deep. It consists of two hulls of equal strength, one within the other. A person may pass between the inner and the outer vessel from stem to stern. The compartments are water-tight, so that if the vessel sustains any injury from grounding or from other cause, only a small part will be filled with water. When in fighting trim, the compartments have water let in so as to submerge the vessel with the exception of about three feet. The masts are also lowered, and nothing rises above the deck save the short smoke-stack, the pilot-house, and the heavy forecastle gun. It has a "ram" snout from which the shell may be thrust out on a long staff. After this explodes, the enemy's ship may receive a thrust from the ram and a shell from the gun. If it be desired to deliver a broadside attack, there are two apertures on each side of the vessel, through which torpedoes may be thrust by means of poles.

**Tor-pe'do-boom.** A spar bearing a torpedo on its upper end, the lower end swiveled and anchored to the bottom of the channel.

The boom sways back and forth, and is difficult to catch by any form of drag or grapple.

**Tor-pe'do-catch'er.** A forked spar or boom extending under water, ahead of a vessel, to displace or explode torpedoes.

**Tor-pe'do-drag.** A cable bearing grappling-hooks to catch torpedoes. The ends of the cable are generally carried in boats some distance apart, which are propelled up and down the channel.

Sometimes the drag-rope is thrown ahead of a vessel by a shell from a small mortar, and drawn in by the windlass.

**Tor-pe'do-fuse.** One adapted for torpedo service, and classed: *percussion*, *friction*, *chemical*, *electric*.

**Tor-pe'do-raft.** A raft pushed ahead of a vessel, with hooks or grapples underneath, to clear the channel of torpedoes.

The raft sometimes carries its own torpedo in front, to blow up obstructions or hostile shipping.

**Tor-pe'do-ram.** One which carries an explosive in the ram to supplement the force of the collision.

**Tor-ri-cel'li-an Tube.** A glass tube invented by Torricelli, open at one end and hermetically sealed at the other. Being filled with mercury, the open end is plunged in a basin of mercury, and the metal falls until its vertical hight is just counterbalanced by the pressure of the atmosphere, — a vacuum termed the Torricellian vacuum being at the upper end of the tube. The discovery furnished the world with the BAROMETER (which see).

Fig. 6564.

*Torricellian Vacuum.*

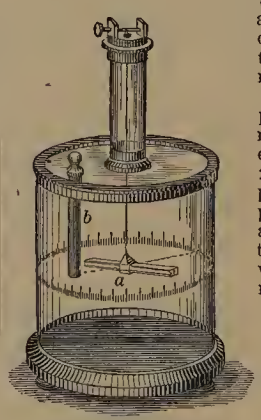
**Tor-ri-cel'li-an Vac'u-um.** So called from Torricelli. See TORRICELLIAN TUBE; BAROMETER.

**Tor'sal.** (*Carpentry.*) A short beam under the end of a girder where it rests on a brick wall.

**Tor'sion-bal'ance.** An instrument originally contrived by Coulomb for electrical purposes. It is, however, equally fitted for measuring magnetic intensity. See ELECTROMETER; GALVANOMETER.

It consists of a glass cylinder covered by a plate which supports an upright tube. From the center of the top of the tube a fine silk thread is suspended, supporting a magnetic needle. The glass cylinder serves to prevent the needle from being disturbed by exterior currents of air, and its circumference is graduated. On bringing a magnet whose strength we wish to measure in contact with the glass, the needle will be deflected to an amount depending on the strength of the magnet employed, and thus the relative intensities of different magnets may be measured.

Fig. 6565.




*Torsion-Balance.*

In that illustrated, the cover is perforated to receive the vertical magnet *b*, whose contrary poles exert an attractive or repulsive force on the nearest pole of the suspended bar-magnet *a*. This is suspended by a fine wire whose resistance to torsion brings the pole of the suspended magnet back to zero when the disturbing magnet is removed.

Fig. 6566.

*Torsion or Slide-Catch Artery-Forceps.*

**Tor'sion-e-lec-trom'e-ter.** An instrument for measuring the force of an electric current by deflecting a needle attached to a wire which is twisted by the movement. See previous article.

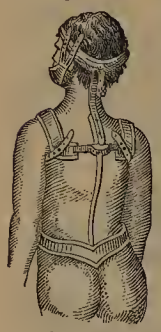
**Tor'sion-for'ceps.** (*Surgical.*) An instrument for twisting the severed ends of an artery; or for holding an artery while a ligature is applied.

**Tor'ta.** A flat circular heap of *slimes* of silver ore, from which the water has partially evaporated till it has become of a proper consistency for tramping. The auriferous or argentiferous slimes are treated by the Patio process, — salt, magistral, and mercury being added to the *torta* and tramped in by animals every alternate day. The heap is also turned by wooden shovels, and subsequently washed, the metalliferous portions being separated from the earthy mud by gravity. See AMALGAMATOR, page 75.

**Tor-ti-col'lis Brace.** (*Surgery.*) An apparatus for remedying distortion of the neck.

Dr. Marcoe's has an upright steel bar fastened to a pelvic band and extending along the spine to a little below the level of the shoulders, secured in position by straps passing over the

Fig. 6567.

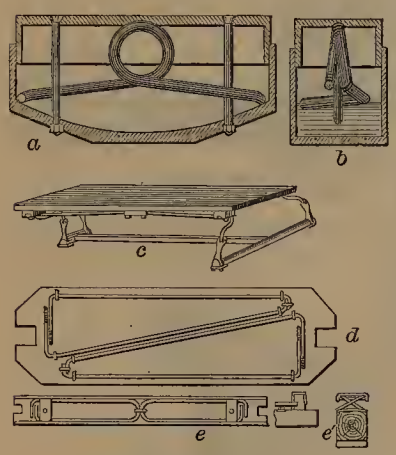


*Torticollis Brace.*

shoulders, under the axillæ, and fastened to buttons or pads over the scapula; to its top is adjustably attached a steel lever which carries a padded spring, forming the head-band, which is provided with a universal joint, so that by means of a thumb-screw the patient's head may be fixed in any position; a baudage passiug from car to ear beneath the chin is attached to the head-band, and a second bandage may bc carricd over the top of the head. See also SPINAL BRACE; SCOLIOSIS BRACE.

**Tor'tion-al Spring.** One in which is utilized the power of a bar to resist a twisting force.

Fig. 6568.




*Tortional Springs.*

*a b* are respectively longitudinal and transverse vertical sections of a car-spring, showing how the bent rod is packed in the chamber so as to utilize the tortional stiffness of the rod.

*c* shows the application of a tortional spring to a carriage-bed. One of its bearings is firmly and rigidly secured to the bolster or other bed-piece, and its other bearing, to which the lateral lever arm is attached, is so arranged as to allow of a partial revolution or a vibratory movement at that point, securing the proper twisting of the rod to develop its torsional action.

*d* has rods beneath the spring-boards, which are pressed flat by the weight imposed, twisting the rods in so doing.

*e e'* are two views of a somewhat similar arrangement. See also *g*, Fig. 1142.

**Tor'toise.** The testudo, or ancient defense, by the soldiers holding their shields over their heads, resembling the carapace of the tortoise.

**Tor'toise-shell.** The use of it in inlaying is mentioned by Pliny.

The plates forming the covering of the *Testudo imbricata*, a species of turtle inhabiting the seas of the torrid zone. The plates are sometimes detached from the living animal by placing it on its back over a fire and applying sufficient heat to soften them, when they are pried off, and the creature is allowed to escape to maturc another crop. The material is translucent, mottled with brown, yellow, and reddish hues, and is used for making combs, boxes, and various ornamental objects. It is softened by boiling water, and may then be pressed by molds into various shapes. It may also be welded while soft by thinning the edges, overlapping and pressing them. When a slit is made, and the piece softened by heat, it may be formed into a ring by stretching. When dry and cold it may be divided with a fine saw, smoothed with a single cut file, technically known as a *quannet*, and then by a scraper. The work is polished on a buff-wheel with rotten-stone and oil.

Fragments, such as cuttings, shavings, and filings, are agglutinated by treatiug with hot water and pressing; the mass may then be molded to any desired shape. This method is much practiced in France.

Tortoise-shell is frequently applied to wood by gluing, forming a veneer. It is also inlaid with the precious metals or mother-of-pearl forced into its substance by pressure while the shell is softened by heat.

It was much used amoug the Romans for decorating furniturc, and is said by Pliny to have been first applied to this purpose by Carvillus Pollio.

Half a century ago it was much employed for ladies' combs, which were then made of enormous size.

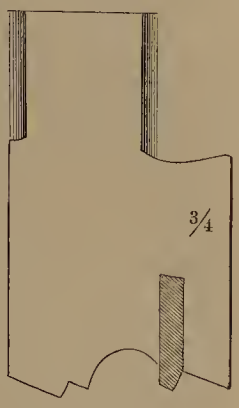
Artificial tortoise-shell is made by melting gelatine with various metallic salts.

Horn may be made to imitate tortoise-shell by brushing it over with a paste composed of two parts lime, litharge, and a little soda lye. The sulphide of lead is formed by the combination of the lead of the litharge with the sulphur contained in the albumen of the horn, producing dark spots which contrast with the lighter color of other parts.

**To'rus.** A semicircular projecting molding, occurring in the base of a column of certain orders.

**To'rus Bead-plane.** A certain form of plane for making the semicircular convex molding known as a *torus*.

Fig. 6569.




*Torus Bead-Plane.*

**Toss'ing.** (*Mining.*) *Tozing.* The operation of agitating ore in a *kieve;* a tub in which it is rotated in water by a stirrer on a vertical axis. See KEEVE; JIGGING. The operation is also called *treloobing.*

**Touch.** 1. (*Shipbuilding.*) The broadest part of a ship's plank worked *top* and *but.*

2. A plan of assaying by color. See TOUCH-NEEDLE.

**Touch-box.** A box with lighted tinder, formerly used by cannoneers to light their matches.

**Touch-hole.** The priming-hole or vent of a gun.

**Touch-nee'dle.** (*Assaying.*) A small bar composed of an alloy of gold and silver, gold and copper, or of gold alloyed with a proportion of both metals, employed in assaying by the touchstone.

A number are employed: one being of pure gold, a second composed of 23 gold and 1 copper, a third of 22 gold and 2 copper, and so on; these are rubbed upou the stone, and the color of the streak compared with that made by the metal to be tested. A farther means of comparisou is afforded by moistening the streaks with nitric acid, or by heating the stone.

Silver is similarly tested by touch-needles composed of lead and silver. See TOUCH-STONE.

**Touch-pa'per.** Paper saturated with a solution of nitratc of potash.

**Touch-stone.** (*Assaying.*) A velvet-black, silicious stone, basalt or flinty jasper, used on account of its blackness and hardness for testing the relative qualities of gold and silver in alloys of the precious metals. A *touch-needle*, composed of an alloy of known fineness, and the piece to be tested, are each rubbed on the stonc and the color of their streaks compared. See TOUCH-NEEDLE.

**Tour-bill'ion.** A paper case filled with inflammable composition, and having holes for the escape of the flame disposed around it so as to cause the ease to rise vertically and rotate on its axis at the same time. It has wings to direct its motion.

**Tour'ists' In'di-cat'or.** A WAYMARKER, PEDOMETER, or other instrument for measuring or automatically mapping a route.

**Tour'ma-line.** 1. A prism of schorl used in polarizing apparatus.

2. *Rubellite* and green tourmaline are used as gems.

**Tour'na-sin.** (*Pottery.*) A knife for the removal of superfluous slip from the baked ware which has been ornamented by the BLOWING-POT (which see).

**Tour'nay.** A printed worsted material for furniture upholstery. *Tournai* in Belgium (Fl. *Doormick*).

**Tour'ni-quet.** (*Surgical.*) An instrument for compressing an artery in amputations. The invention of Morelli, 1674, modified by other distinguished surgeons. Also used in compressing aneurisms and tumors. See Fig. 212, page 103.

The screw-tourniquet was invented by Petit of France, 1718. The form now in common use, an improvement on that of Petit, was patented by Savigny of London in 1800. Improvements have also been made by Nuck, Verduc, Monro, and others.

The heroes before Troy had one field physician, but in general the soldiers of the armies of the ancients, or sympathizing females, gave what attention they could to the wounded. In the Roman army each cohort had a physician. The first trace of

field-hospitals is in the sixth century. The convention of Ratisbon, 742, ordered that every army should have a corps of chaplains, and every colonel a confessor, but does not refer to a medical staff.

Gustavus Adolphus appointed four surgeons to a regiment.

The essential parts of a tourniquet are a pad, which is compressed upon the severed artery above the point of division, and a band, by which it is tightly held to the limb.

*a* (Fig. 6570) is Tiemann's direct-pressure tourniquet. Both sides of the pad are free from pressure, so as not to stop the circulation of the venous blood.

*b*, Petit's spiral tourniquet.

*c*, United States Army field-tourniquet.

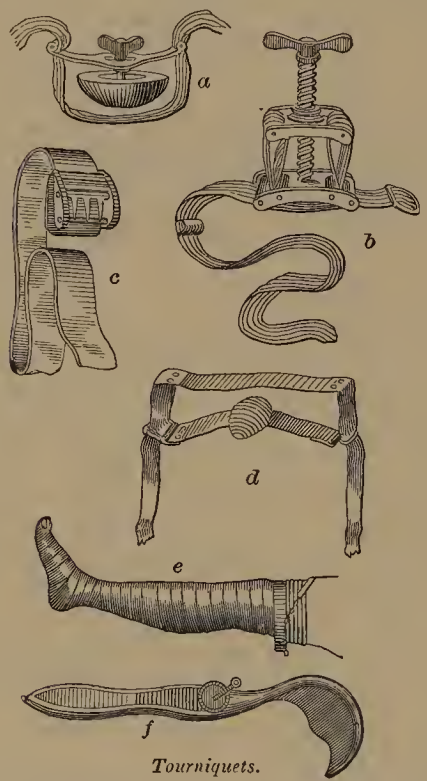
*d*, Valentine Mott's tourniquet.

*f*, Lawrence's eye-tourniquet.

*e*, tourniquet by Professor Esmarch of Kiel, particularly adapted for operations, as necrotomy, in which a great effusion of blood is to be apprehended.

The lower portion of the limb is enveloped in oiled silk, to prevent soiling the bandage, and an elastic rubber bandage is then tightly wrapped around the lower part of the limb, forcing the blood out of the vessels. Above the termination of the bandage, an india-rubber cord is wound four or five times around the limb, and its two ends are joined by a hook upon one entering a link of the chain attached to the other. In order to perform the operation, the oiled silk and bandage are removed; when completed, the rubber cord is slowly unwound, and any small arteries which may have remained unnoticed, tied. This tourniquet can be adjusted to any portion of the limb, and the location of the principal arteries need not be considered. The compression of the soft parts and arteries by the rubber tubing is so complete that no blood can enter the bandaged portion of the limb.

Fig. 6570.




*Tourniquets.*

**Tow.** The coarse part of hemp or flax separated from the finer by the *hatchel* or *swingle*. The longer and fine fiber is called *line*.

**Tow-boat.** A steam-tug.

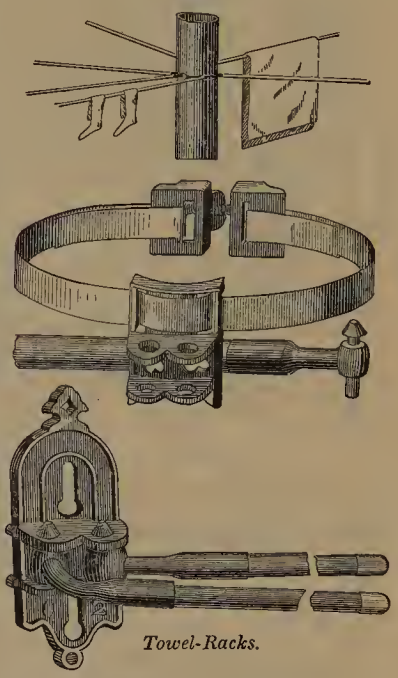
**Tow'el-ing.** Coarse linen fabric, such as huck-a-back, diaper, etc.

**Tow'el-rack.** A frame or rod on which to hang towels to dry. Fig. 6571 shows two kinds: one has a strap clamped to the stove-pipe; the next is an enlarged view of the same; the lower one has a plate screwed to a wall or piece of furniture, and several jointed rods projecting from it.

**Tow'er.** (*Architecture.*) A structure, lofty in proportion to its base, and circular or polygonal in plan, frequently consisting of several stories. In a church, that part which contains the bells and from which the steeple rises.

Towers, beginning with that of Babel, have been erected from the earliest ages as memorials, and for purposes of religion and defense. In latter years, as shot-towers and chimneys of manufacturing establishments, they have been built of great hight for purposes of practical utility.

Fig 6571.

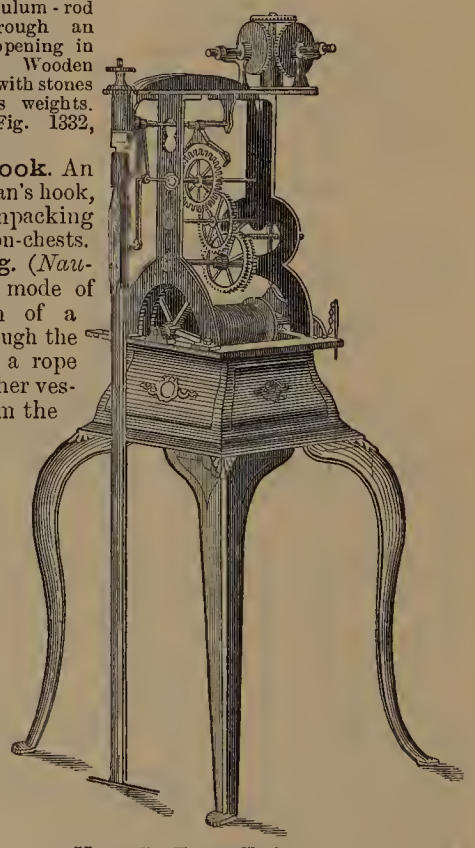


*Towel-Racks.*

**Tow'er-clock.** A large clock designed for church turrets and similar situations.

That shown in Fig. 6572 has the works arranged in an iron case having legs which are bolted to the floor; the pendulum-rod passes through an elongated opening in the floor. Wooden boxes filled with stones are used as weights. See also Fig. 1332, page 570.

Fig. 6572.



*Howard's Tower-Clock.*

**Tow-hook.** An artilleryman's hook, used in unpacking ammunition-chests.

**Tow'ing.** (*Nautical.*) A mode of propulsion of a vessel through the water by a rope from another vessel, or from the shore, or by a rope laid along a canal or river and passed over a drum on board the vessel.

In harbors tow-boats, or *tugs*, are specially devoted to this purpose. On canals horses or mules are generally employed. The substitution of other motors for animal power has of late years engaged much attention, and various other means have been either tested or proposed. Prominent among these is the system introduced into Belgium, and employed on the Erie Canal, between Albany and Troy. In this a submerged wire rope is employed resembling a telegraph cable, and passing

over a drum, rotated hy the engine on the tow-hoat. This drum has pivoted clips which clasp the rope as it presses upon their feet and let it go after passing over the drum; a roller then presses upon the cable, causing it to descend iu a nearly perpendicular direction to the hottom, so that its slack may not act as a drag on the boat. The tug is designed to tow six canal-boats, at a speed of three miles an hour.

The "Nythia" tug is operated by this means on the Danube. This boat has a length of 138 feet, beam 24½ feet, depth of hold 7½ feet, two false keels, and a rudder at the bow and stern worked by separate wheels placed nearly amidships. She is propelled hy twin screws, 4½ feet in diameter, worked by two vertical engines near the how, and supplied with steam by the same boilers which work the clip-drum machinery.

The clip-drum has a diameter of 10 feet 6 inches, it is keyed to the end of thc main shaft, overhanging the boat on the port side. Two swiveled guide-pulleys, of the same diameter as the drum, are employed to conduct the rope, which passes above the first and beneath the second, to the clip-drum; a third similar pulley behind the drum directs the rope downward. The how of the hoat slopes downward to the water's edge, permitting the rope to pass freely over it at any angle. With eight harges in tow, this boat has attained a speed of 5¾ miles an hour, making a progress of nearly 3 miles an hour against a current of over 2¾ miles.

Chain towage is also used on the river St. Lawrence, for propelling the tugs which bring the vessels up the rapids below Montreal. The cahle of 7,000 length was laid in July, 1873. The power is ohtained from a pair of long-stroke engines, 22-inch cylinder, 5 feet stroke. The chain barrels are 2 feet in diameter, and carry 9 tons of 1¼-inch short-link chain. The engineer was Mr. A. G. Nish.

**Tow'ing-bri'dle.** (*Nautical.*) A chain with a hook at each end for attaching a towing-rope to.

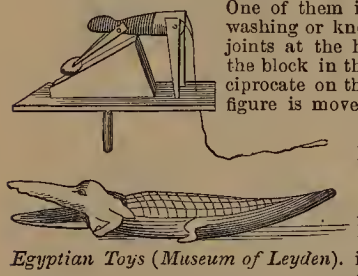
**Tow'ing-path.** The track on the *berme* of a canal for the draft animals.

**Tow'ing-post.** A stout post on the deck of a tug-boat to fasten the towing-line to.

**Tow-line.** (*Nautical.*) A hawser or rope used in towing a ship or canal-boat; a *tow-rope.*

**Toy.** Among the more serious historical matters disinterred from the Egyptian tombs are a number of dolls and toys.

Fig. 6573.



*Egyptian Toys* (*Museum of Leyden*).

The cut illustrates two of the latter. One of them is the figure of a man washing or kneading dough, and has joints at the hips and arms, so that the block in the hand is caused to reciprocate on the inclined plane as the figure is moved by the string. The other figure represents a crocodile having its upper jaw hinged, as in nature.

The game of thimhle-rig occurs in a paiuting, and the illustration is from the work of Professor Rosellini.

Toys have been disinterred by General di Cesnola from the tomhs of Golgoi and Idalium in Cyprus, — painted dolls of clay modeled with the fingers; mounted cavaliers armed with shields, or horses attached four abreast to cars. One, a horse a foot in length, rolling on movable wheels, was found in a diminutive grave, older probably than Hector and Andromache.

The toys of the Roman children were of various kinds; some found at Pesaro were little leaden gods and goddesses, with altars and sacrificial instruments (*Lararium puerile*). They had also puppets, geometrical figures of ivory to he fitted together, dolls, terra-cotta figures with arms and legs moved by a string, like the modern *patins* and *marionettes;* popguns, blow-guns, bows and arrows, tops.

Hooker, the naturalist, states that he was amused at the Monastery of Doobdi, in Sikkim, which is on the flank of the Himalayas, by watching a child playing with a popgun, made of hamboo, similar to that of quill, with which most English children are familiar, which propels pellets hy means of a spring-trigger made of the upper part of the quill. "It is easy," he says, "to conclude such resemblances between the familiar toys of different countries to be accidental, hut I question their being really so. On the plains of India men may often be seen, for hours together, flying what with us are children's kites; and I procured a jews-harp from Thibet. These are not the toys of savages, hut the amusements of people more than half civilized, and with whom we have had indirect communication from the earliest ages. The Lepchas play at quoits, using slate for the purpose, and at the Highland games of 'putting the stone' and 'drawing the stone.' Chess, dice, draughts, Punch, hocky, and hattledoor and shuttlecock, are all Indo-Chinese or Tartarian."

Wooden carved toys are almost exclusively produced in the hilly wooded regions of Germany and Switzerland, where they are generally carved hy the peasants, when not employed in farm labors, the whole family, even to the smaller childreu, taking a part in the work.

The cheaper kinds, as Noah's arks, soldiers, tea-sets, etc., are principally produced iu the vicinity of the Black Forest, Nuremberg being the principal depot.

Sonneburg, in Thuringia, exports ahout 25,000 cwt. of the hetter class of wooden toys, made in the town and vicinity.

Switzerland excels in wooden cottages, models, etc., and France in mechanical or clock-work toys.

Rocking-horses, carts, velocipedes, drums, doll's houses, and a variety of other articles, are made in large quantities in London. The United Statcs makes its own toys of the larger kind, riding-horses, volocipedes, etc., hut the small ware is yet largely imported.

"France and Germany are the chief competitors in the toy market, — the first for taste, and the second for cheapness. The peasants of Saxon Switzerland spend their winter evenings in cutting out the immense supply of farmyards and their appropriate animals, soldiers of every nation, and houschold implements of every kind, which, dispatched to Paris from Olbernau, in fragile wooden boxes, are sold for two or three francs. Beasts, covered with velvety coats, colored according to the animal, are made at Rodach, toys in porcelain at Ohrdruff; whilst the baby dolls, simply attired, come from Sonnenherg, Neustadt, and Wallerhausen. Men made in plaster are dispatched to us from Prussia, whilst leaden soldiers, measuring about an inch iu hight, painted and heavily armed, come from Bavaria, Nuremherg, and Furth. Household utensils in china — such as pipkins, saucepans, cups and saucers, dolls' heads in china, games of lotto, penny watches, wooden wheelharrows, spades, and rakes — are made in the departments.

"The Quartier du Temple, in Paris, produces all other toys. The population of that curious old quartier arc now wholly occupied by toy-making, and each workman has his speciality. For instance, the man who makes rahbits striking on a drum with their fore-paws makes no other toy. Of these there are annually 43,200 sold, prime cost, at four and sixpence a dozen.

"There are six manufactories of brass trumpets in Paris alone. 200,000 are monthly made in this city. Their prime cost is 1*s.* 3*d.* per dozen, and the supply never equals the demand. They are made of oak or beech; the wood employed is sent from Villers Catteress; the parchment from Coutances and Issoudun.

"Of dolls the number is legion. One manufacturer alone supplies the children of this capital with 50,000 per annum; and it would be impossible to detail the scores made of scraps of indefinite materials, put together hy poor seamstresses living in garrets, to bc sold by women still poorer crouched heneath a *porte-cochère*, now shivered hy the bitter hlast, and a few months hence scorched hy the hlazing sun. Thesc dolls for the humhle are made hy no rule, but the *bebes* for the rich employ several separate trades. There are workmen who stretch the flesh-tinted leather with which they are covered, and nail it on hoards, that it may acquire the requisite suppleness; others cut the skin into the shape required to cover legs, arms, etc.; others line these detached pieces with calico; others, again, fill the sewn skin with bran. A separate branch of the trade is that of adapting heads and arms to the bran-filled hodies. These heads, when in porcelain and paste, come from Germany, whereas waxen occiputs are molded and tinted in Paris. Wig-making for dolls employs three separate trades, namely, makers of human hair wigs, of wigs manufactured from the Thibet goat, and those of lamb skin. Dolls' shoes have a trade to themselves. It appears that combs for these inanimate coquettes are only to he found in the Rue Acunaire, where is a *fabrique* of dolls' combs." — *London Star.*

"The tin toys used in this country are now nearly all made in Meriden, Counecticut, where large quantities of tin household goods are also manufactured.

"Wooden toys, of the less fragile kind, are largely manufactured in several Connecticut towns, and in New York and Philadelphia. These consist of childreu's wheelbarrows, drums, rocking-horses, carriages, carts, blocks, rail-cars, hoops, sleds, etc.

"The patentees of the new sensation toys, as the dancing negro, the returning ball, and Quaker popgun, are said to have made fortunes. The railway train, and several other new toys, have also had great temporary success. Red india-ruhher balloons are made in France, and filled here with gas.

"Pewter toys, comprisiug soldiers, landscapes, trees, etc., are now largely made in this country, though many are yet imported from Germany.

"The stuffed hodies of dolls are made in New York, Boston, and Philadelphia, as also the arms; but Germany still sends many. The arms of stuffed dolls arc an especial article of commerce. They are not, like the legs, attached to the hodies, hut are sold separately. The heads are likewise purchascd, and are either of French porcelain and finely featured, of German china or papier-maché, of English wax, of American india-ruhher, or of an imitation of papier-maché. This latter is of thin layers of muslin, coated with oil paint, which has the advantage of washing without injury, and is exceedingly strong, though hy no means of fine finish.

"India-rubber hollow toys of every description, except halls, grotesque masks and birds, and men that squeak when squeezed, are among our own productions.

"Mechanical toys, such as imitation steam-engines, steamers, etc., are made here; as also kaleidoscopes. A negro jig-dancer, propelled by steam, is the latest Yankee notion. A kerosene lamp heats a small brass vessel full of water and shaped like a top. It revolves in its socket, and moves a wire which communicates with the figure.

"Clay marbles come exclusively from Saxony, and are prepared in molds by machinery, from a clay not found in other countries. The material for agate marbles is obtained in the Hartz Mountains of Germany.

"A Japanese top has been lately in vogue, and several Chinese toys have been for years in use.

"Croquet instruments are made in Pawtucket and Providence, Rhode Island, and in Boston and Springfield, Massachusetts. Maple is the wood principally used, though lignum-vitæ is sometimes employed. For more expensive kinds boxwood is the material. Small balls, for parlor use during the winter months, are also made. The new game of martelle employs the same woods. The parlor balls are of ivory." — *Commercial Advertiser.*

Fig. 6574.

*T-Iron.*

**T-plate.** 1. An angle-iron of T-form, having two branches.

2. A carriage-iron for strengthening a joint, such as at the intersection of the tongue and cross-bar; the coupling-pole, or reach, and the hind axle.

**Trace.** 1. (*Saddlery.*) A strap, chain, or rope, attached to the hames, collar, or breast-band of a harness, and to the single-tree or other part of a vehicle, and by which the vehicle is drawn.

Traces were not common in ancient Egypt, or among other contemporary nations. The animals, whether horses, asses, or cattle, were yoked to the tongue. Sometimes *one* trace passed back from the yoke along the tongue. No such thing in old Egypt as a breast-band or collar combined with a pair of traces.

Fig. 6575.

*Trace-Fastener.*

There were no draft or pack animals in Mexico of any kind. They appear to have had no beef or mutton, and so ate each other and dogs.

Traces are shown in Froissart and Du Cange.

2. (*Fortification.*) The ground plan of a work.

**Trace-buck'le.** (*Saddlery.*) A long heavy buckle used in attaching a trace to a tug.

**Trace-chain.** (*Saddlery.*) A wire chain used as a trace.

**Trace-fas'ten-er.** A hook or catch to attach the hind end of a trace to a single-tree or splinter-bar.

In Fig. 6575, the spring, acting upon the fastening pin through the pivoted lever, retains the pin securely in the position in which it holds the trace.

**Trace-hook.** A hook on the end of a single-tree or splinter-bar, to which is attached the harness-trace. When the trace has a cock-eye, it is looped over a stud driven into the end of the single-tree.

There are, however, many modes of attaching. Fig. 6576 shows several.

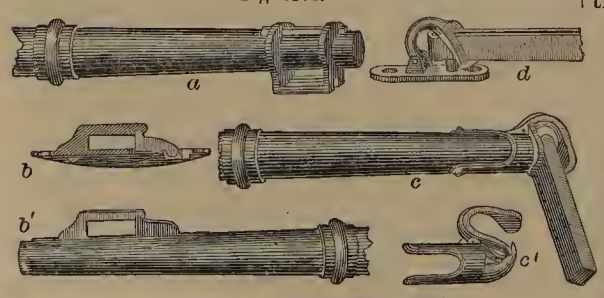
*a* has an iron loop which is passed through the loop at the end of the trace, then slipped upon the single-tree, and held by a spring-latch.

*b b'* are detached and *in situ* views of a trace-hook, with a spring-latch to form a mousing.

*c c'* are views of a trace-hook with a hinged latch-piece, which is kept closed by pulling on the trace, but is readily detached by a specific movement.

*d* is a hold-back hook for the strap of the breeching.

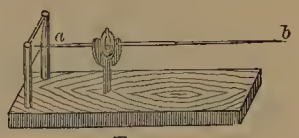
Fig. 6576.




*Trace-Hooks and Hold-Back Hook.*

**Trace-loop.** (*Saddlery.*) A square metallic loop used to attach a coach-trace to the trace-post or end of the evener-bar or single-tree.

Fig. 6577.



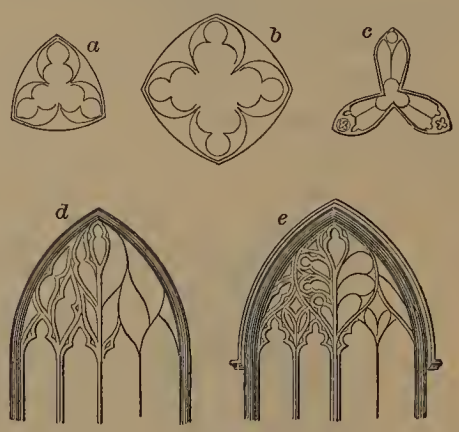

*Tracer.*

**Tra'cer.** A kind of silhouette instrument for transcribing on a different scale, or marking on a surface at *a* the outlines of an object at *b*.

**Tra'cer-y.** (*Architecture.*) The species of pattern-work formed or traced in the head of a Gothic window by the mullions being continued, but diverging into arches, curves, and flowing lines enriched with foliations. The styles varied in different ages and countries.

*a b c*, elements of German tracery.
*d*, French flamboyant tracery.
*e*, English leaf-tracery.

Fig. 6578.




*Tracery.*

**Tra'che-o-tome.** (*Surgical.*) A kind of lancet with a blunt and rounded point, mounted on a handle and fitted to a canula which passes along with it, and is allowed to remain in the opening made in the trachea. It is used for making an opening to remove foreign substances, or to permit passage of air to the lungs.

*a*, probe-point tracheotomy-scalpel.
*b*, Pitha's tracheotome and dilator.
*c*, Langenbeck's tracheotome.
*d*, Langenbeck's tracheotomy double-hook.
*e*, Buck's tracheotomy-guide.
*f*, Tiemann's tracheotome and dilator.
*g*, Trousseau's dilator.
*h*, Tiemann's tracheal forceps.
*i*, double trachea-tube.
*j*, Johnson's obdurator.
*k*, Tiemann's universal forceps.

**Tra'che-a-for'ceps.** A long curved forceps for extracting articles which may have accidentally intruded themselves into the windpipe or throat. See *h* and *k*, Fig. 6579.

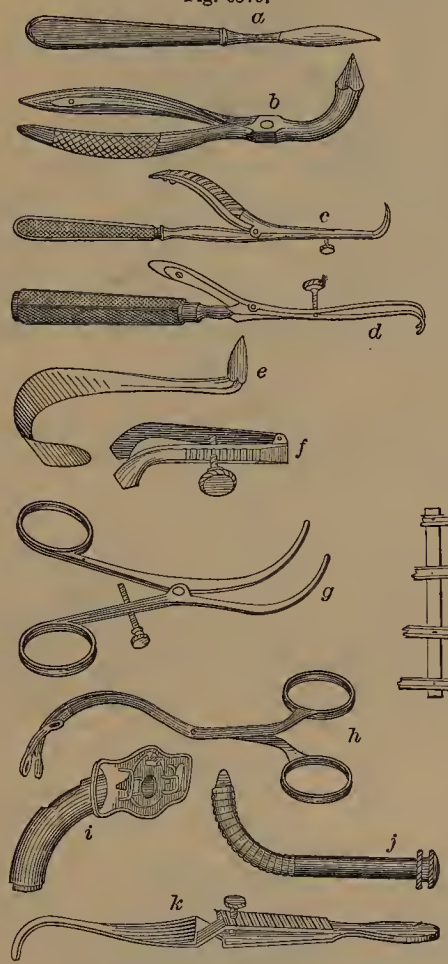
**Tra'che-ot'o-my-tube.** (*Surgical.*) A tube to be placed in an opening made through the walls of the trachea to permit passage of air to the lungs in case of stricture of the larynx, or the presence of foreign bodies in the air-duct. The operations of *laryngotomy*, *tracheotomy*, and *bronchotomy* are essentially similar, the terms being derived from the name of the part whose walls are penetrated to remove foreign bodies or permit passage of air to the lungs. Fig. 6580 shows several forms of tracheotomy-tubes, with buttons or shields to prevent the

canula from accidentally slipping entirely into the trachea.

**Tra'cing-in'stru-ment.** An instrument for copying figures on an enlarged or reduced scale. Its principle is the same as that of the profile-machine.

A long straight arm and a shorter curved arm have a universal-joint movement about a common point. The longer arm being passed over the outlines of an object, the shorter arm, which is provided with a pencil or tracer, produces a copy on a smaller scale, upon a sheet held in proper position to receive

Fig. 6579.




*Tiemann's Trachea-Instruments.*

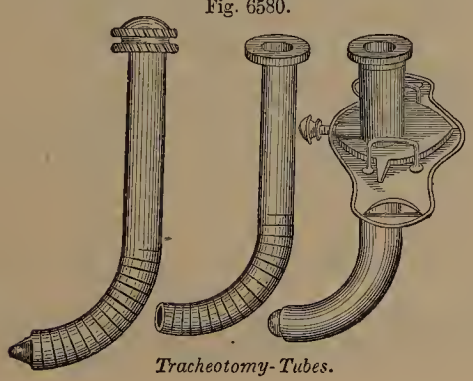
it; or the functions of the two may be reversed, producing an enlarged copy. The *silhouette* instrument is similar.

**Tra'cing-pa'per.** A tissue-paper of even body treated with oil, solution of resin or varnish, to render it transparent.

Various formulas are given for preparing it.

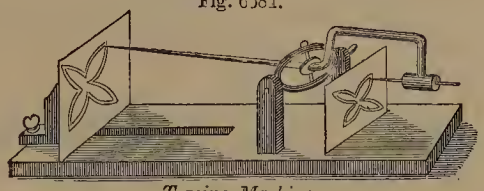
1. Dip the paper in a mixture of equal parts Canada balsam and camphene, and dry.

Fig. 6580.



*Tracheotomy-Tubes.*

Fig. 6581.



*Tracing-Machine.*

2. One ounce Canada balsam and one gill spirits of turpentine; dissolve with gentle heat, and spread the mixture with a brush on one side of good tissue-paper.

3. Moisten the paper with equal parts of nut-oil and spirits of turpentine, dry immediately by rubbing with wheaten flour, and hang up to complete the drying.

4. A German process recently patented consists in saturating the paper, preferably writing-paper, with benzine, and before this evaporates applying a varnish prepared as follows: boiled bleached linseed oil, 20 parts; lead shavings, 1; oxide of zinc, 1; Venice turpentine, ½. Mix, and boil eight hours; when cool, strain and add white gum copal, 5; gum sandarach, ½. The varnish may be applied by dipping, or with a brush or sponge.

The following are the sizes usually met with: —

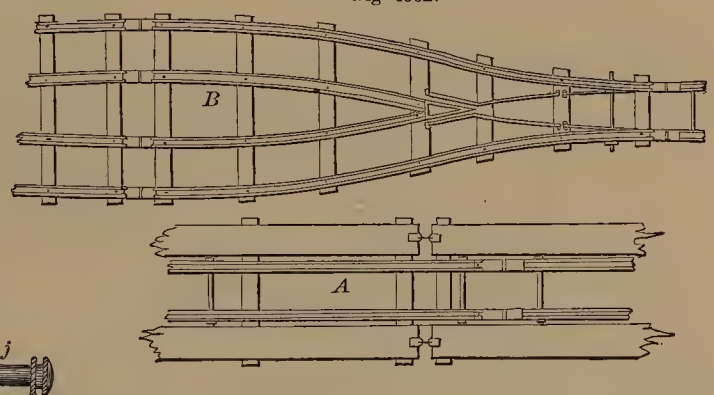
| | |
|---|---|
| Double Crown | 20 × 30 inches. |
| Double D. Crown | 30 × 40 inches. |
| Double D. D. Crown | 40 × 60 inches. |
| Grand Royal | 18 × 24 inches. |
| Grand Aigle | 27 × 40 inches. |

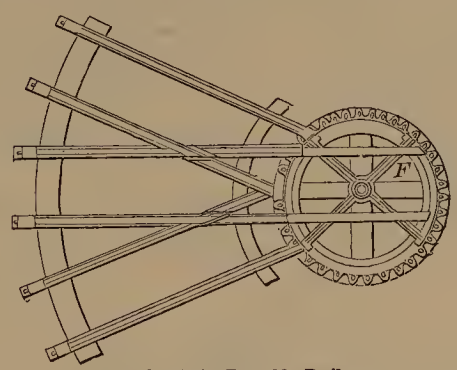
Vellum Writing, 18 to 28 inches wide.

**Track.** (*Railway.*) The rails on which the locomotives and cars travel. The *way*. See RAIL.

Stimpson's patent of August 23, 1835, extended till 1852, was a great advance in the construction of railway-tracks. He

Fig. 6582.




*Peteler's Portable Railway.*

made rails with gutters to hold the flanges of the wheels and avoid obstruction to passing carriages; guttered crossing-plates of cast iron; running the flanges of the outer wheel on top of the outer curve while the flange of the wheel on the inner curve ran in a guttered rail, or the tread of the inner wheel running on the flat of the rail while the outer wheel-flange ran on top of the rail.

Collyer, 1867, has two flanges on the wheels, the outer and smaller of which runs on the inner curve in turning.

Fig. 6582 illustrates a portable railway for excavating and constructing purposes; the sections *A* of railway, the turnouts *B*, and turn-tables *F* are dragged along the ground into position, laid on sleepers, and locked together for use.

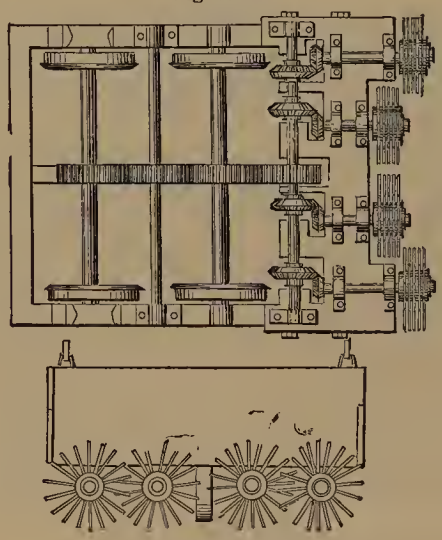
**Track-boat.** One pulled by a towing-line, as on a canal. See TOWING.

**Track-clear'er.** 1. (*Railway.*) *a.* A cow-catcher in front of, or bars extending down from the front frame of the locomotive, to push objects from the track.

*b.* A track-sweeper to remove snow.

In Fig. 6583, the brushes are rotated by gearing connection to the axles, and are made of radials of whole rattan inserted in a hub. See also SNOW-PLOW; STREET-SWEEPER.

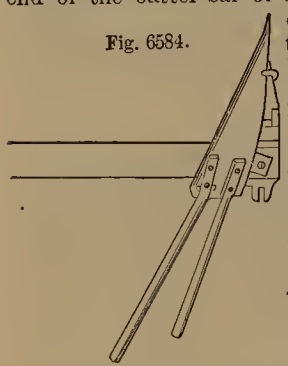
Fig. 6583.



*Track-Clearing Machine.*

2. (*Harvesting.*) A triangular frame on the outer end of the cutter-bar of a mowing or reaping machine to draw the grain toward the cutter and leave a clear track for the grain-wheel in the next round.

Fig. 6584.



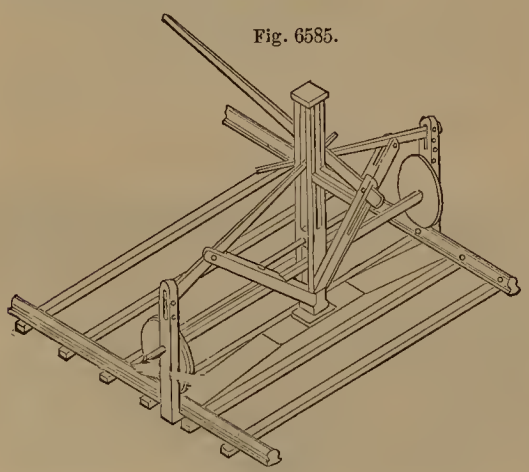
*Track-Clearer for Mowing-Machines.*

**Track-har'ness.** (*Saddlery.*) A breast-collar single harness, made up in the lightest and plainest manner.

**Track-lay'er.** (*Railway Engineering.*) A carriage provided with apparatus for placing the rails in their proper positions on the track as the machine advances over a portion of the track already laid down. Robertson's patent, No. 82,350.

**Track-rail.** (*Railway Engineering.*) A rail for the tread of the wheel, in contradistinction to a guard-rail, for instance. See RAIL.

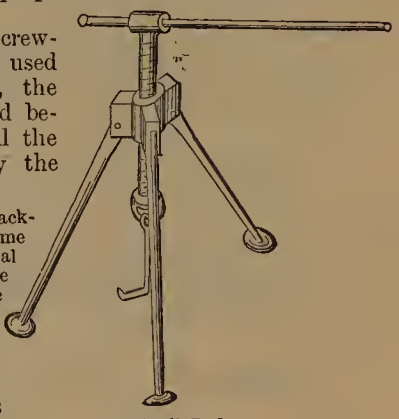
Fig. 6585.



*Track-Lifter.*

**Track-rais'er.** A lifting-jack for raising rails which have become sprung below the proper level.

Fig. 6586.



*Rail-Jack.*

Fig. 6585 is a screw-jack on a tripod, used for this purpose, the hook being placed beneath the rail and the screw rotated by the handspike.

Fig. 6586 is a track-lifter in which the frame has wheels for removal on the track. The claws take under the rails, and are raised by the compound levers.

**Track-scale.** One which weighs a section of railway-track with the load thereupon. The Fairbanks track-scale is shown under WEIGHING-SCALE.

**Trac'tion.** The adhesive friction of a wheel on the rail, a rope on a pulley, etc. The tractional surface of a driving-wheel is the face of its perimeter.

**Trac'tion-en'gine.** A locomotive-engine for drawing heavy loads upon common roads, or over arable land, as in agricultural operations.

Some of the earliest locomotive-engines, as Murdock's, were designed for this very purpose.

One of the earliest forms of traction-engine was Boydell's. This had endless chains of boards fitted to its wheels, forming a sort of endless railway which was laid down and taken up by the engine as it proceeded; the wide bearing afforded by these enabled the engine to travel over soft ground.

Bray's had very wide wheels, provided with sliding plates which were protruded through openings in its periphery and withdrawn by central eccentrics. These embedded themselves in the ground and caused the machine to advance. Compare ROAD-LOCOMOTIVE, ROAD-ROLLER, ROAD-STEAMER, etc.

Figs. 6587, 6588, show that of Thomson of Edinburgh, who first applied rubber tires to this class of engines, as improved by Williamson of New York.

The framing, *a a*, is of wrought-iron, in a single piece. The rims of the driving-wheels *b* are perforated with numerous holes into which the back of the rubber tires *c* are forced, obviating slippage; these are surrounded by endless chains *d*, armed with bars of steel, and held in position by a flange on each side of the wheel. The boiler *e* is of the upright tubular kind, and connects with two steam-cylinders whose pistons operate crank-shafts turning gears which cause the wheels to revolve. By means of appropriate levers the gears may be shifted so that the drivers may be caused to make six or eighteen revolutions to one of the crank-shaft. The gear on one side may also be thrown out while that on the other is working, thus facilitating the turning of abrupt corners.

By means of a reversing gear *f* the engine may be run either forward or backward.

The steering-wheel *g*, through the medium of a vertical shaft and bevel-gears, changes the direction of the single front wheel by which the machine is guided. The water-tank *h* is provided with a suction-pump by which it may be filled from a running stream or other convenient source. One of the coal-bunkers *i* is placed on each side of the platform on which the fireman stands.

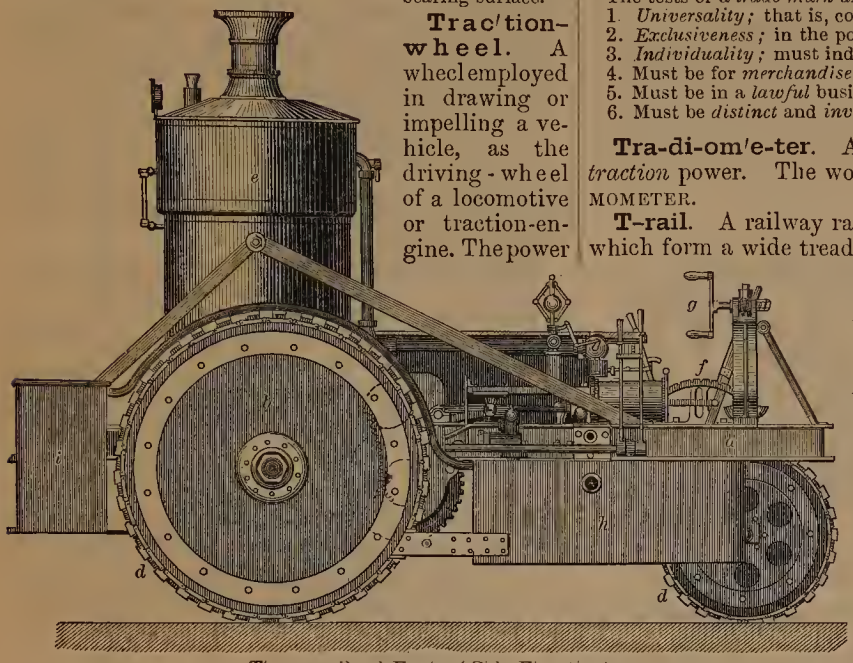
Fig. 6589 is Longstaff and Pullan's traction-engine; its general features do not differ essentially from those of others previously described. Its minor details are, however, according to the Mechanics' Magazine, so arranged as to render it one of the most efficient machines of this class. By a peculiar mode of suspension of the boiler, priming is obviated, and ten hours' work may be performed without refilling the tank. See also ROAD-LOCOMOTIVE; ROAD-ROLLER.

**Trac'tion-gear'ing.** An arrangement for turning a wheel and its shaft by means of friction or adhesion.

In Fig. 6590, the peripheries of the two wheels *a b* are grooved to receive the band *c*, by which they are both rotated in the same direction. The circumference of the driven wheel *d* is

doubly beveled to correspond with the grooves in the driving-wheels, that it may have a greater bearing-surface.

Fig. 6587.




*Thomson Road-Engine (Side Elevation).*

**Trac'tion-wheel.** A wheel employed in drawing or impelling a vehicle, as the driving-wheel of a locomotive or traction-engine. The power is applied to the wheel, and the frictional adhesion of the rotating-wheel on the rail or ground is the immediate cause of progression.

**Trac'tor.** An obstetric forceps.

**Trade.** (*Mining.*) *Attle*, or rubbish.

**Trade-mark.** An arbitrary symbol affixed by a manufacturer or merchant to a vendible commodity. The principal purpose of a trade-mark is to guarantee the genuineness of a product. It is, in fact, the commercial substitute for one's autograph. In all ages it has been used to denote origin, and thus to protect the purchaser as well as the vender. All countries protect the integrity of trade-marks, and nearly all civilized nations have treaties or conventions securing reciprocity of protection.

The tests of a *trade-mark* are: —

1. *Universality;* that is, commonly recognized as such.
2. *Exclusiveness;* in the possession of the owner.
3. *Individuality;* must indicate origin and ownership.
4. Must be for *merchandise.*
5. Must be in a *lawful* business.
6. Must be *distinct* and *invariable.*

**Tra-di-om'e-ter.** A measurer of *drawing* or *traction* power. The word is a bungle. See DYNAMOMETER.

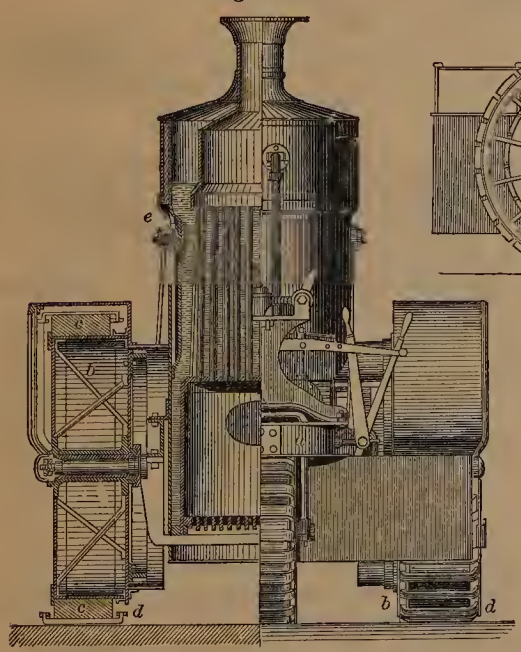
**T-rail.** A railway rail having two flanges above, which form a wide tread for the wheels of the rolling stock. The vertical web is gripped by the chairs, which are spiked to the ties. Invented by Birkenshaw, 1820. See RAIL; RAILWAY.

**Trail.** (*Ordnance.*) The end of the stock of a gun-carriage, which rests upon the ground when a gun is "unlimbered," or in position for firing. The stock proper is inserted into a forked iron plate, the *lunette*, having a loop wrought on its outer extremity, which is passed over the pintle-hook of the limber when the gun is limbered up.

2. (*Architecture.*) A running enrichment of leaves, flowers, tendrils, etc., in the hollow moldings of Gothic architecture.

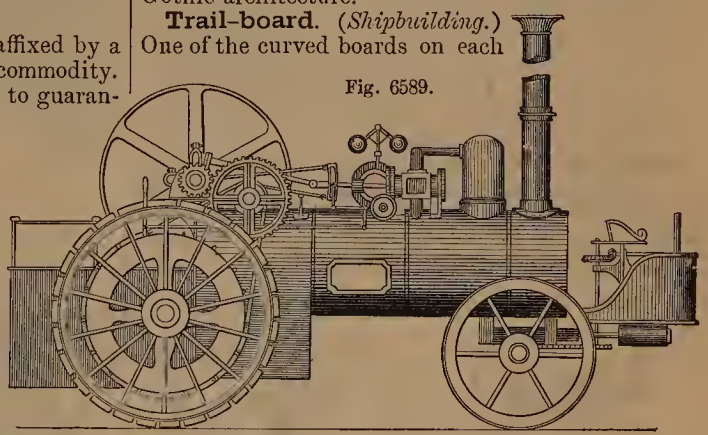
**Trail-board.** (*Shipbuilding.*) One of the curved boards on each side of the stem, reaching from it to the figure-head.

Fig. 6588.




*Thomson Road-Engine (End View and Section).*

Fig. 6589.



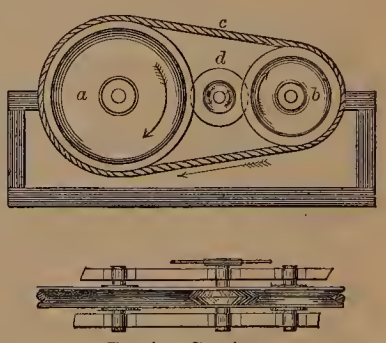
*Longstaff and Pullan's Traction-Engine.*

**Trail'er.** A self-acting brake formerly used on inclined planes. A *stopper.*

**Trail'ing-ax'le.** An axle behind the driving-axle in British locomotives.

**Trail'ing-spring.** In British locomotives, the springs fixed on the axle-boxes of the trailing-wheels of a locomotive-engine, which bear slightly against the side frames, so as to leave as much weight as possible upon the

Fig. 6590.




*Traction-Gearing.*

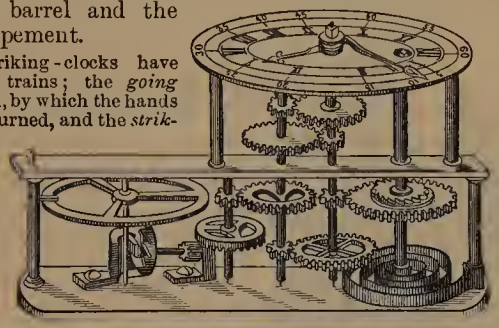
driving-springs, and to assist in deadening any shock which may take place.

**Trail'ing-wheel.** One of the wheels of a locomotive not concerned in the driving.

**Trail-net.** A net drawn or trailed behind a boat; or by two persons on opposite banks in sweeping a stream.

**Train.** 1. (*Machinery.*) A set of wheels, or wheels and pinions in series, through which motion is transmitted in regular consecution: *e. g.* the *train* of a watch; the wheels intervening between the barrel and the escapement.

Fig. 6591.



*Watch-Train.*

Striking-clocks have two trains; the *going* train, by which the hands are turned, and the *striking* train, by which the striking part is actuated. Watches and clocks which do not strike are destitute of the latter.

2. (*Ordnance.*) *a.* A certain number of field or siege pieces, organized and equipped for a given duty.

*b.* The hinder part of a gun-carriage; the *trail.*

3. A line of combustible material to lead fire to a charge or mine. See BLASTING; FUSE.

4. (*Metallurgy.*) Two or more pairs of connected rolls in a rolling-mill and worked as one system.

The first pair are known as the *muck*, or *puddle-bar train*, and the finishing as the *merchant-train.*

5. (*Railway.*) A series of cars coupled together.

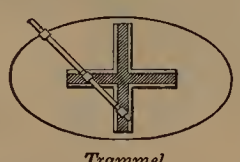
6. (*Vehicle.*) A heavy long sled used in Canada in hauling wood or merchandise.

**Train'ing-bit.** (*Manege.*) A wooden gag-bit used when training vicious horses. The cheeks are of iron, and are connected by a rod or iron which passes through the wooden mouth-piece, having a head upon one end and a nut on the other.

Fig. 6592.

*Training-Bit.*

Fig. 6593.



*Trammel.*

**Train'ing-hal'ter.** (*Manege.*) A halter made in the same manner as a riding-bridle, with the exception of having short instead of long cheeks, which are provided with rings into which bit-straps may be buckled.

**Train'ing-lev'el.** (*Ordnance.*) An instrument for leveling or training guns. See LEVEL.

**Train'ing-pen'du-lum.** (*Ordnance.*) An instrument having a pendulum and a level member, with a glass and bubble; used in training guns to any required elevation.

**Train-road.** (*Railway.*) A construction railway; a slight railway for small loads.

**Train-tack'le.** (*Ordnance.*) A purchase by which a gun-carriage is secured to a ring-bolt in the deck, to prevent running out while loading.

**Train-way.** A hinged platform which forms a bridge leading from a wharf to the deck of a ferry-boat.

**Tra-jec'to-ry.** (*Ordnance.*) The curved line described by the center of gravity of a projectile in its flight.

**Tram.** 1. (*Mining.*) A four-wheeled truck for carrying a *corve*, *hutch*, or *basket* on a pair of rails in a mine, or in carrying the coal or ore. The *tramway* was the first iron railway. See RAILWAY.

2. One of the rails of a tram-road.

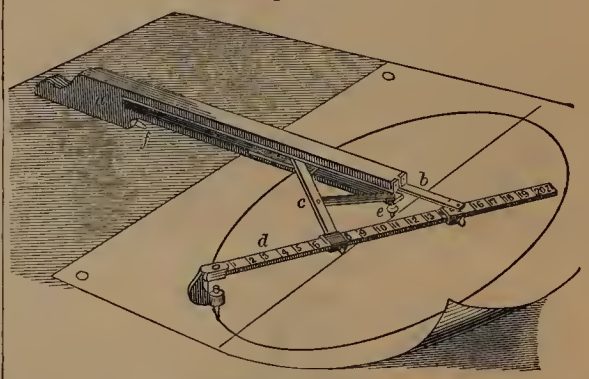
3. (*Silk-manufacture.*) A thread of silk formed of two or more *singles* twisted together in a direction opposite to that of the *singles;* used for the *shoot* or *weft* of some description of goods. *Organzine* is double-twisted, like a rope.

**Tram-car'riage.** (*Mining.*) The carriage (usually of iron) employed on a tram-road. A *tram.*

**Tram'mel.** 1. (*Drafting.*) *a.* An ellipsograph consisting of a cross with two grooves (Fig. 6593), which form guides for two pins on a beam compass. The pencil on the beam is directed in a prescribed elliptical path as the pins slide in the grooves. Each pin travels in its own groove, and makes four strokes for each revolution of the pencil. This double reciprocation has occasioned its adoption in machines which require speedy motion See TRAMMEL-WHEEL.

Bowly's *trammel*, or *oval compass* (Fig. 6594), consists of a slotted stock *a*, in which slides a bar *b*, and a protractor *c*, united to the graduated scriber *d* by adjustable sockets. One end of the scriber has a swivel-holder for a pen, pencil, cutting-blade, or glazier's diamond. The arms *b c* may be set so as to describe

Fig. 6594.



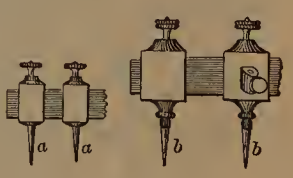

*Bowly's Trammel.*

ellipses of varying proportions. The instrument turns on a pin *e*, and a pointer *f* at the end of the slot determines the direction of one axis of the ellipse; it may be so adjusted that either the longer or the shorter axis may be parallel with the stock.

*b.* A *beam-compass.*

*a a* (Fig. 6595) are *trammel-points*, to be placed on a long bar for striking large circles. They are held at the desired points by set-screws, and the larger sizes (*b*, Fig. 6596) have an arrangement for holding a lead-pencil.

Fig. 6595. Fig. 6596.




*Trammels, or Beam-Compasses.*

2. A shackle to put on a horse's leg to teach him to pace.

3. A long sweep-net for birds or for fish.

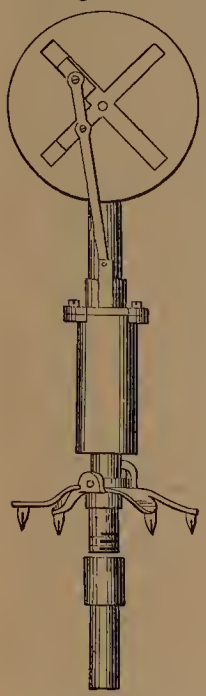
4. A pothook, hung in a chimney.

**Tram'mel-wheel.** Sometimes called a *slosh-wheel.* It was patented in 1836 by B. F. Snyder, and has been used by McCurdy for operating the needle of a sewing-machine. It has also been used for driving a saw, or gang of saws.

This wheel has two slots crossing each other at right angles and forming guides for two sliding-blocks, to which a pitman is connected. The rim of the wheel is not an essential part. As the wheel rotates, the sliders keep in their own grooves, crossing each other's tracks, and the pitman makes two up and two down strokes for each revolution of the wheel. This compara-

tively rapid execution makes the device useful for small pumps, churns, etc. See Fig. 3894, B, page 1769.

Fig. 6597.



*Trammel-Wheel.*

A modification of the trammel is found in the annexed multiple-gearing, in which the wheel with six slots is driven by the revolution of the wheel with three arms. Each arm has an anti-friction wheel at the end, which traverses the slots. Each revolution of the small wheel makes a half-revolution of the trammel-wheel.

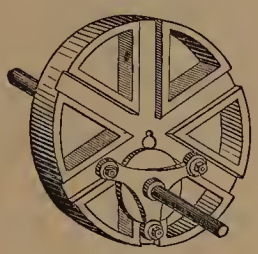
**Tramp.** 1. An iron sole-piece worn beneath the shoe to protect the foot and the shoe from injury when digging.

2. A tool for trimming hedges.

**Tram-plate.** The first form of iron railway-rail.

It was patented by Carr of Sheffield,

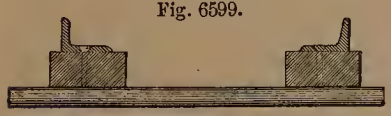
Fig. 6598.



*Trammel Multiple-Gearing.*

1776. Previous to this time, the wooden trams had been protected by malleable iron plates, a practice introduced at Newcastle about 1602. The Coalbrookdale Iron Company substituted cast-iron plates 5 feet long, 4 inches broad, and 1¼ inch thick; this was in 1767. Carr was the first to make the iron rail. Jessop made edge-rails of cast-iron in

Fig. 6599.

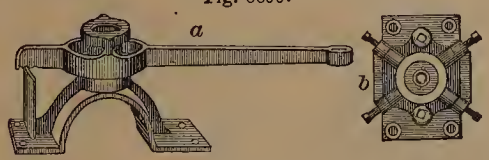


*Tram-Plates.*

1789. Birkenshaw introduced the rolled rail in 1820.

**Tram'pot.** (*Milling.*) The support in which the foot of the spindle is stepped. The arched trampot *a* is used for straddling the driving-shaft where bevel-

Fig. 6600.




*Trampot.*

gear is employed. The more common form *b* has a movable center adjustable by means of four set-screws.

**Tram-road.** A road in which the track for the wheels is made of timbers, flat stones, or iron, while the horse-track between is left sufficiently rough for the feet of the horses.

One was laid down in 1602 in the neighborhood of Newcastle by Beaumont, and was in use in 1676. It is not likely that they would be disused until superseded by railways. They are described by Roger North in 1676 as being rails of wood grooved to form tracks for the wheels which traversed therein.

An iron tram-road was laid between Wandsworth and Croydon, in England, in 1802.

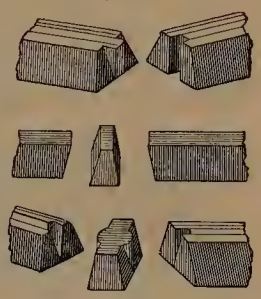
A flagstone tram-road was laid in the Commercial Road, London, before 1829. On it the merchandise of the East and West India Docks was transported to the city of London.

Iron railways were laid down by Carr at Sheffield, 1776, and by the Coalbrookdale Iron Company in 1786 See RAILWAY.

Matthews's stone tram-way (English) has stones 4 feet 2 inches in length, 14 inches wide at base, 11 inches at top, and 10 inches deep. He proposed several mortise and tenon joints, shown in the illustration, to give mutual vertical and lateral support.

**Tram-staff.** (*Milling.*) A miller's straight-edge, which is employed to test the squareness of the spindle with the face of the stone.

Fig. 6601.



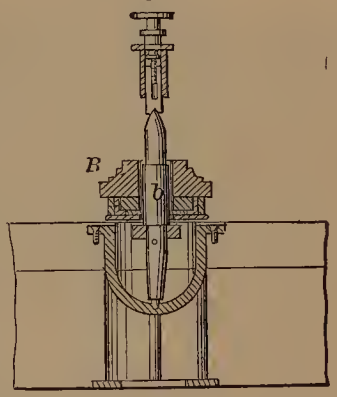
*Matthews's Tram-Joint.*

The gage-staff *B* is centered upon the millstone by means of the circular center fitting over and around the spindle *b*. *k k* are spirit-levels.

The *red-staff* is a straight rule with a red edge, to lay upon the stone and touch with red any prominent parts, in order that they may be reduced to the general level.

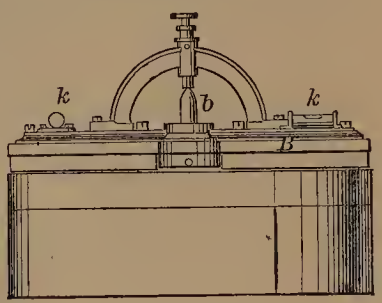
**Tram-way.** A wooden or iron way adapted to *trams*, that is, coal-wagons. It was the precursor of the railway. They were originally of wood, and first made in England in 1600. See TRAM; TRAM-ROAD; RAILWAY.

Fig. 6602.




**Tram-way Mo'tor.** The English name for the locomotive which is not used on rails. See TRACTION-ENGINE; ROAD-LOCOMOTIVE; STEAM-CARRIAGE; STREET-RAILWAY CAR.

**Tram-wheel.** A wheel used on the small cars employed in mining and excavating operations, and which run on what in England are known as *tram-ways*. These in general have wooden rails merely faced with iron.




*Tram-Staff.*

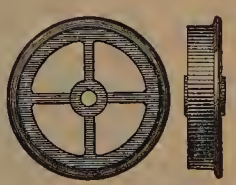
**Trank.** (*Glove-making.*) An oblong piece cut from the skin, and from which the shape of the glove is cut on a knife in a press.

**Tran'sept.** The north and south *arms* of a cruciform church, assuming the building to be correctly aligned, the choir to the east.

**Trans'fer.** An impression taken on paper, cloth, etc., and then laid upon an object and caused to adhere thereto by pressure.

In engraving, a tracing may be made in pencil and transferred to the *ground* by running through the plate-press. See ENGRAVING.

Fig. 6603.



*Tram-Wheel (Mining).*

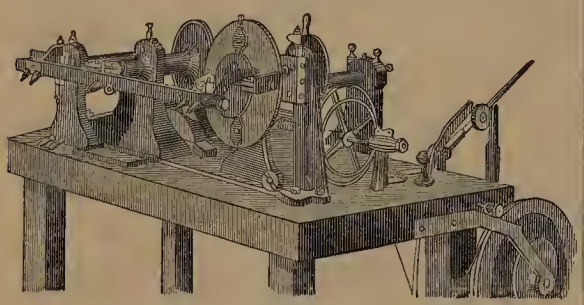
An impression from a plate or stone may also be transferred to a stone, as in the processes described under LITHOGRAPHY, section 3, page 1334.

In Kuehn's mode of making pictures by transfer, the different colors requisite for a picture are printed

on sized paper and successively transferred to a japanned plate.

To obtain a transfer larger or smaller than the original, an impression is taken upon india-rubber, by one of several modes: To effect it on an enlarged scale, the surface of a sheet of vulcanized india-rubber, equal in size to the subject, is coated with a thin film of an elastic composition, and on it is taken an

Fig. 6604.



*Transfer-Lathe.*

impression of the print, block, or plate. By means of a peculiar expanding frame, the sheet of india-rubber is now stretched on all sides simultaneously till it attains the size required. While retained in this form, it is laid down on a lithographic stone, or zinc plate, properly prepared, which is then in a condition to furnish impressions by the ordinary method.

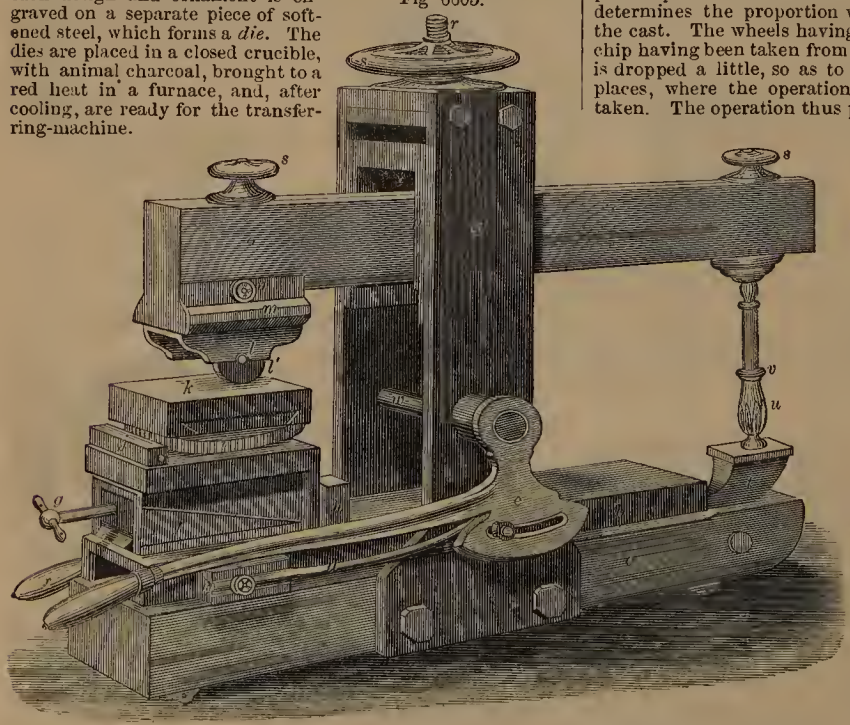
The reduction of the object is obtained by stretching a comparatively small piece of india-rubber till it can cover the subject; the impression being then taken, it is released from the strain and returns to the original size, and the process is finished by transferring it to a stone or plate.

For surface-printing it is transferred to a plate, which is then *bit away* in the parts not covered by the ink, leaving the impression salient. From this a matrix is taken by the electrotype process, and this, by a repetition of the process, furnishes a block from which impressions may be had by the usual surface-printing process. The use of the camera is now general and preferable.

**Trans-fer'ring-ma-chine'.** (*Engraving.*) This machine is used by bank-note engravers to obtain upon rollers cameo copies of engraved dies, and to transfer impressions from the rollers to the plates, from which notes, etc., may be printed.

In bank-note and similar engraving, the views, portraits, and ornaments are not engraved immediately upon the plate from which impressions are printed, but each design and ornament is engraved on a separate piece of softened steel, which forms a *die*. The dies are placed in a closed crucible, with animal charcoal, brought to a red heat in a furnace, and, after cooling, are ready for the transferring-machine.

Fig 6605.



*Castlear and Tichenor's Bench Transfer-Press.*

The die is placed on the adjustable bed-plate of this machine, and a softened steel roller is placed in the oscillating head above. Arrangements are made for bringing the parts in perfect apposition, so that the roller may come in contact with the die in the required place. The die and roller being then brought forcibly together, the roller is made to revolve over the die, and the metal of the former is pressed into all the lines of the die, making a cameo or salient impression of the engraving.

The roller is then hardened, and is ready for delivering an impression to a bank-note plate. The pressure of the roller upon the plate in the transferring-machine is given by a system of compound levers, and is regulated by the pressure upon a treadle of the foot of the operator, or by a hand-lever. The rolling is repeated again and again by rocking it back and forth until the steel of the roller has insinuated itself fully into every line of the die, whether heavy or light, and the larger machines can give a pressure of 35 tons.

When a bank-note is ordered, the directors make choice of the designs they require, each being on a separate piece of paper, as printed from the die. The choice being made, the arrangement is to be determined, and the rollers are then brought forward to deliver their impressions separately upon the face of the plate, which is attached to the bed-plate of the transferring-machine. Thus each view, ornamental letter, portrait, lathework, rosette, or star is transferred to the plate. The *lettering* is then engraved upon it with the graver, or by die. By lettering is meant the name of the bank and such matters. These completed, it is ready for the printing-press. See also TRANSFER-PRESS; BANK-NOTE ENGRAVING.

**Trans'fer-lathe.** (*Coining.*) For the purpose of reducing large designs in relief, to proportions suitable for coin, a machine has been invented in France and imported into the United States Mint.

If the design has been made in wax or other soft material, a cast in metal is taken of it, and from this copy, properly fixed in the transferring-machine, the engraving is made on the end of the *hub* from which *dies* are to be *sunk*.

The brass cast is fastened to the larger wheel of the machine, and the softened steel plug to the small wheel on an arbor parallel to the former. These wheels revolve at an equal rate. Across the front of the machine, opposite the faces of the cast and the steel block, is a horizontal bar, pivoted at one end to a standard on the bed-piece, and drawn toward the faces of the cast and block by a spring.

On this lever are two important parts of the machine. A steel stub projects against the face of the copy and a graver against the face of the steel block. Now, as the two wheels revolve, the cameo or salient design on the copy thrusts out the stub, and the graver is withdrawn in the equivalent ratio from the steel. When the steel stub traverses the flat face of the copy, the graver does the same on the steel.

The relative distance of the stub and the graver from the pivotal point of the lever-bar, to which they are both attached, determines the proportion which the engraving shall bear to the cast. The wheels having made a revolution, and a circular chip having been taken from the steel, the outer end of the lever is dropped a little, so as to bring the stub and graver to other places, where the operation is repeated, another chip being taken. The operation thus proceeds till the whole face of the casting and steel have been traversed, the latter being a "copy in little" of the former. The roughnesses and graver-marks are dressed off by the tools of the die-sinker.

**Trans'fer-pa'per.** Prepared paper used by lithographers, or for copying in a press. See page 1330.

**Trans'fer-press.** Fig. 6605 is a bench transfer-press, invented by George W. Casilear and George W. Tichenor of the United States Treasury.

The following statement of parts will sufficiently describe it, in connection with the previous description and the other articles,—BANK-NOTE ENGRAVING; STEEL-PLATE ENGRAVING; etc.

*a*, bed
*b*, carriage.
*c*, carriage-lever, which gives the motion.
*d*, connecting-rod.
*e*, adjustable slide.
*f*, wedge.

*g*, screw.
*h*, wedge-post.
*i*, division.
*j*, dog and spring.
*k*, slide and table.
*l*, railway.
*l'*, roll.
*m*, rocker for leveling the roll.
*n*, screws for moving the rocker.
*o*, beam.
*p*, beam-box in which the beam swings.
*q*, uprights.
*r*, screw for raising beam.
*t*, fulcrum.
*u*, adjustable fulcrum-rod.
*v*, check-nut.
*w*, shaft.
*x*, lever of fulcrum which gives the pressure to the beam.

**Trans'fer-print'ing.** A name applied to the processes of *anastatic printing*, *chemitype*, and *paneiconography*.

In the first a printed sheet is moistened with dilute acid and pressed upon a zinc plate, which becomes etched in those parts which have not been touched by the ink; a mixture of gum and water being applied adheres to the etched portions, leaving the inked parts intact. On passing an inked roller over its surface the ink adheres to the printing, but is repelled by the rest of the plate, so that impressions may be taken from it in a copper-plate-press.

In *chemitype* a zinc plate is varnished, etched, and the etching bitten in with acid; the etched lines are then filled up with molten fusible metal, which is afterward scraped down to a smooth level; strong acid is then applied, which eats away the zinc, leaving the fusible metal in relief to print from.

In *paneiconography* the design is transferred from a print or lithograph, or else drawn by hand, with lithographic ink, on a zinc plate. An inked roller being drawn over the plate, the new ink adheres to the old, and is strengthened by being sprinkled with powdered rosin. Acid is applied, which eats away the zinc between the printed lines, leaving the latter in relief to print from.

**Trans-fer'rer.** A base-plate for an air-pump receiver, which enables the exhausted receiver to be removed from the air-pump.

**Trans-fu'sion-ap'pa-ra'tus.** Apparatus for transfusing blood from one living animal into the veins of another. The idea of renewing vital power by the transfusion of the blood seems to have been familiar to the ancients, and is found in the works of the alchemists of the Middle Ages, who imagined that it might be the means of perpetuating youth.

Various successful experiments were tried upon the lower animals, but the first recorded operation of the kind on a human subject was by Dr. Denis of Paris, who, in June, 1667, injected eight ounces of arterial blood from a lamb into the veins of a child.

Subsequently calf's blood was infused into the veins of a maniac, who, shortly after, regained his reason.

These successes led to numerous other attempts of the kind, but the general results were such that the practice was forbidden by the Parliament of Paris in 1668.

The injections were, in these cases, performed by means of a common syringe.

The operation was performed in England at the same period, and was practiced by Lower, 1691.

"A man that the college [Gresham] have hired for 20*s.* to have some of the blood of a sheep let into his body, and it is to be done on Saturday next. They purpose to let in about 12 ounces, which they compute will be let in in a minute's time by a watch." — PEPYS's *Diary*, 21 Nov., 1667.

The experiment was performed at Arundel House two days afterward, upon the person of Arthur Coga. ("Phil. Trans.," No. 30, page 557.)

Pepys states that, on the 14th November, 1666, the blood of one dog was passed into the side of another, the latter losing its own blood by the opposite side. The first dog bled to death; the latter, whose blood had been substantially withdrawn and substituted, recovered. He suggests letting the blood of a Quaker into an archbishop to amend the life of the latter.

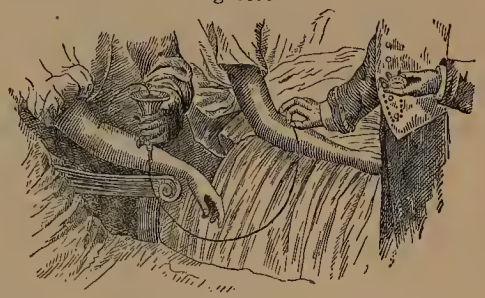
After the lapse of a century the subject was taken up by Harwood, whose researches proved that blood could not be transfused from one animal to another belonging to a different natural family without fatal results to the latter. More modern experiments, particularly those of Prevost and Dumas, show that the blood of calves or sheep injected into the veins of a cat or rabbit is fatal, and mammals, into whose veins the blood of birds is transfused, die. The experiments of Milne-Edwards and Lafond indicate that this result does not take place when the animals belong to nearly allied species; thus an ass, whose blood was nearly exhausted, was reanimated perfectly by the blood of a horse.

The difference of results in these cases appears to be attributable to the different sizes and shapes of the blood globules in animals; these vary much in different species, and later investigations show that the blood of those species whose globules do not differ greatly in form and dimensions from those of man may be injected without injurious results.

Prevost and Dumas have shown that serum — that is, blood deprived of its fibrin and globules — is of no effect; while, on the other hand, when the fibrin has been destroyed by agitation, leaving the globules intact, strong revivifying effects are produced.

Fig. 6606 represents the process as practiced in Paris. The bared arm to the left is that of the blood-donor; the other that of the person into whose veins the blood is injected. The blood flows from the arm of the former into a cup, is pumped from the lower part of the cup, and forced through a canula

Fig. 6606.



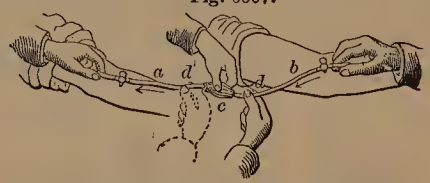
*Transfusion-Apparatus.*

into the veins of the patient.

In order to prevent coagulation of the blood, the instrument is immersed in tepid water; the tubes used are of gold.

The aspirator is so arranged that no air can possibly enter with the blood.

Fig. 6607.




*Aveling's Transfusion-Apparatus.*

Aveling's apparatus is shown in Fig. 6607. The following directions are given for using it:—

The apparatus is immersed in a basin of tepid water, and the air expelled by compressing the bulb.

The arm of the patient having been bound, a fold of skin over a vein at the bend of the arm is raised, transfixed, and divided.

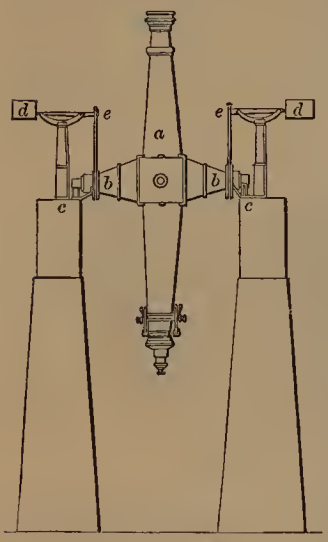
The vein is now seized with a pair of fine forceps, raised, an incision made into it, and a bevel-pointed silver tube *a* inserted. When this tube is taken out of the water it is kept full by placing the thumb over its orifice. The arm of the blood-donor being brought into close proximity to that of the recumbent patient, an incision, as in ordinary blood-letting, is made into his arm, and the round-pointed tube *b* inserted therein, by an assistant. The india-rubber part of the apparatus, filled with water, and kept so by turning the cocks at each end, is now fitted into the two tubes, the cocks are opened, and the operation commenced by compressing the india-rubber tube on the efferent side *d*, and squeezing the bulb *c*; this forces two drachms of water into the afferent vein. Next shift the hand from *d* to *d'*, and compress the tube on the afferent side, allowing the bulb to expand slowly, when blood will be drawn into it from the efferent vein. By repeating this process, any quantity of blood can, at a desired rate, be transmitted, the amount being measured by counting the number of times the bulb is emptied.

**Tran'sit.** 1. (*Astronomical.*) The transit-instrument is the most important of what may be called the technical astronomical instruments. The smaller and portable kinds are used to ascertain the local time by the passage of the sun or other object over the meridian, while the larger and more perfect kinds, in first-class observatories, are used for measuring the positions of stars, for forming catalogues; its special duty being to determine with the greatest accuracy the right ascension of heavenly bodies.

In the latter case it consists of a telescope *a* supported on a horizontal axis *b b*, whose extremities terminate in cylindrical pivots resting in metallic supports *c c*, shaped like the upper part of the letter Y, and hence termed the "Y's," and imbedded in two stone pillars. In order to relieve the pivots from friction and facilitate the turning of the teleseope, counterpoises *d d* are provided operating through levers *e e*, carrying friction-rollers upon which the axis turns. When the instrument is in proper adjustment, the telescope should continue in the plane

of the meridian when revolved entirely round upon its axis, and for this purpose the axis must lie in a truly east and west line. To effect this adjustment its ends are provided with screws by which a motion, both in azimuth and altitude, may be imparted.

Fig. 6608.



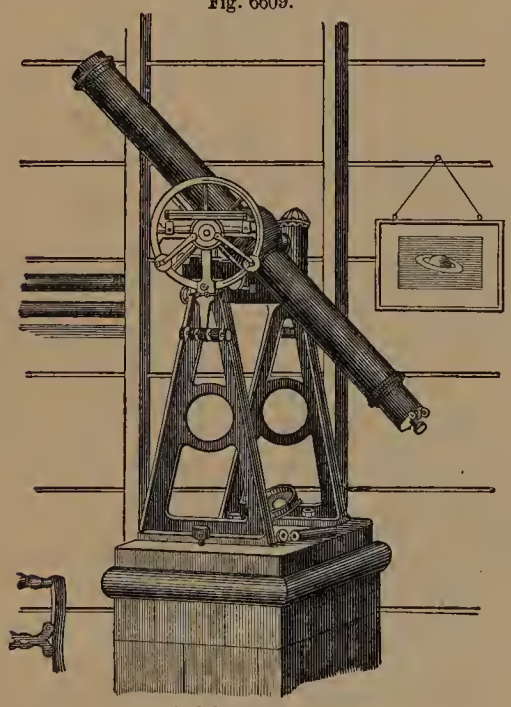

*Transit-Instrument.*

Fig. 6609 shows the transit of the Uckfield Observatory, England. The frame supporting the axis is of metal, and rests on the top of a pillar of masonry.

All instruments of this kind have a diaphragm, consisting of a single horizontal wire and a number of vertical wires, placed in the center of the field of view, and illuminated at night by a lamp throwing its light through one of the trunnions, which is made hollow for the purpose, upon a mirror set at an augle of 45° to the axis of the tube, which reflects it on to the wires. At the extremity of the other axis is a vertical circle, provided with a vernier, for measuring declinations. Levels are also attached to adjust the instrument to perfect horizontality, or to indicate the correction to be applied to the observation if this adjustment be imperfect.

The portable transit merely differs from the foregoing in being mounted upon a metallic stand, capable of being transported from place to place, and being readily set up at the point of observation. The base of the stand rests upon three foot-screws, by which, in connection with the levels, the horizontal adjustment is made.

Fig. 6609.

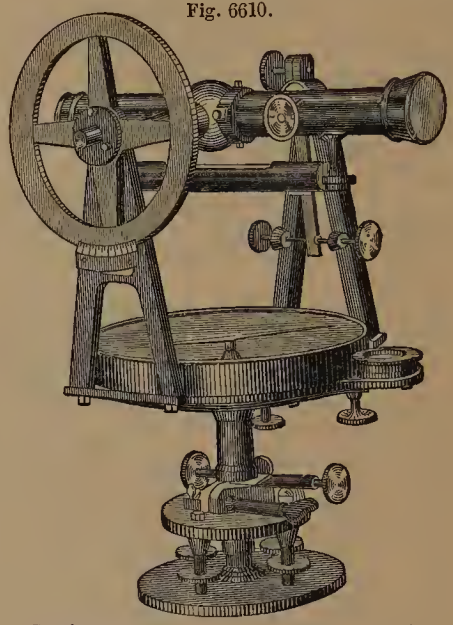


*Uckfield Transit.*

The transit instrument in the National Observatory, Washington, has an object-glass with a clear aperture of 5½ inches, and a focal length of 88 inches. It is mounted upon piers of granite, which rest on a foundation of stone, extending 10 feet below the surface of the ground. The cost of this instrument was $ 1,480. The object-glass was valued at $ 320.

The transit in the prime vertical was made by Pistor and Martins of Berlin. The object-glass of the telescope has a clear aperture of 5 inches, with a focal length of 78 inches The eye-tube carries a system of 2 horizontal and 15 vertical stationary wires, with one movable vertical wire. This instrument is mounted at one end of its axis, and outside of its supports. It is reversed from one side to the other twice during every observation; and though it weighs upward of 1,000 pounds, so perfect is the system of counterpoises, and the reversing apparatus, that it can be manipulated by a child. The cost of this instrument was $ 1,750.

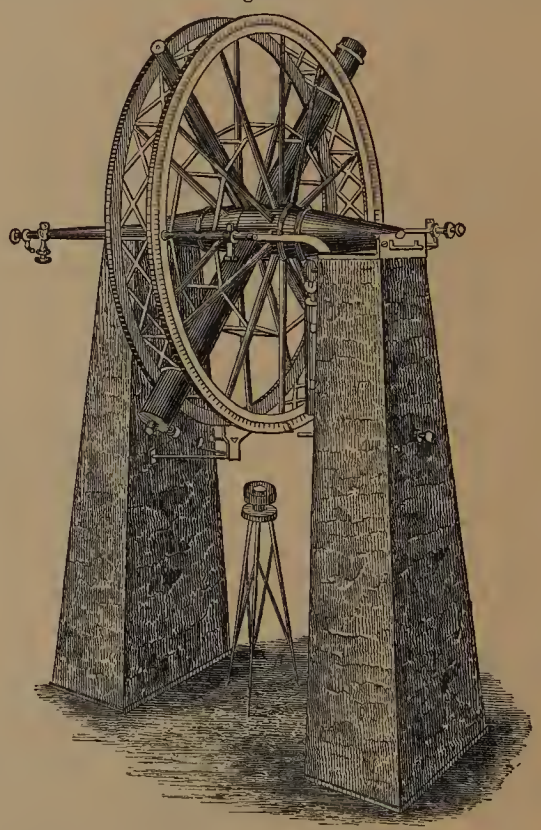
Fig. 6610.



*Engineers' and Surveyors' Portable Transit.*

A transit-instrument by Bauer of St. Petersburg has the eye-piece situated in the axis on which the telescope rotates. A reflecting prism in the middle of this axis receives the light from the objective and deflects it at right angles to its original position. The observer is thus enabled to maintain an unchanged position, always looking in a horizontal direction.

Fig. 6611.



*Troughton's Transit-Circle.*

2. (*Engineering.*) The surveyor's transit is a portable instrument of the theodolite kind, designed for

measuring both horizontal and vertical angles. It is provided with horizontal and vertical graduated circles, one or two levels, and a compass, and is mounted upon a tripod-stand. See THEODOLITE.

**Tran'sit-cir'cle.** Troughton's transit-circle (Fig. 6611) unites the functions of the mural circle and the transit-instrument.

The telescope is fixed between two parallel, flat metallic circles, or rings, the exterior faces of which are graduated to 5′. These rings are connected with the horizontal axis by two sets of hollow, radial arms, so as to form two wheels 4 feet in diameter, and are connected with each other by a system of transverse and diagonal rods. The axis, 3 feet in length, consists of a central cylindrical portion into which the spokes are inserted, and two projecting cones resting on Y's in two stone piers. The faces of these piers coincide with the plane of the meridian. The Y's are provided with vertical and horizontal adjustments for placing the line of collimation of the telescope exactly in the plane of the meridian.

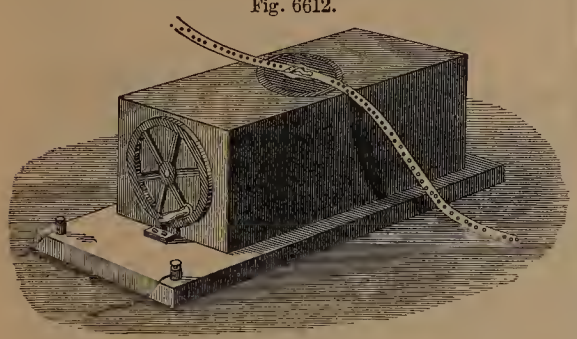
**Tran'sit-in'stru-ment.** See TRANSIT.

**Trans-la'tor.** (*Telegraphy.*) An instrument, such as a relay, for repeating a message upon a second circuit when the line-current of the former circuit is too feeble to carry the signal to the ultimate station. A *repeater*.

**Trans-mit'ter.** (*Telegraphy.*) The sending or dispatching instrument, especially that under the automatic system, in which a paper strip with perforations representing the Morse or similar alphabet is passed rapidly through an instrument called an automatic *transmitter*, in which the contacts are made by metallic points wherever a perforation occurs, and are prevented where the paper is unpierced.

The *transmitters* of various electricians agree in the respect noted, but vary in details. That shown is the Wheatstone, in

Fig. 6612.



*The Wheatstone Transmitter.*

which the perforated ribbon-paper strip is caused to advance step by step through the machine by the successive grips of an oscillating cradle, regulated to advance the paper a distance exactly corresponding to the previous spacing of the holes by the *perforator*, so that by the action of a rising pin, elevated and depressed alternately at each to-and-fro motion of the rocking-frame, the message-ribbon is automatically and mechanically impelled forward. Two other spring *contact*-pins are actuated by the same mechanical movement, by means of eccentric cam arrangements. Thus, when the perforated paper ribbon is carried automatically forward step by step, in rapid succession, by the action of the central pin, if a *current-passing perforation* is in position at the moment of passing the paper ribbon with either pin, the respective pin will rise through the hole and make a metallic contact with the battery through the instrument, sending a current into the line. If no perforation in the paper ribbon is in position at the time of the automatic elevation of the respective pins, they fall back by the compensating influence of adjusting springs, and a *mute* movement is made, forming an interval in the alphabetical system.

**Trans-mit'ting Mo'tion.** Items of information on this subject will be found under the appropriate headings, embracing details, such as *shafting, clutch, pulley, band, wheel, gearing, wire-rope, air as a means of transmitting motion*, etc.

**Tran'som.** 1. (*Building.*) A horizontal piece framed across a doorway or a double-light window.

2. (*Shipbuilding.*) A beam bolted across the stern-post, supporting the after end of a deck and giving shape to the stern. The *third, second,* and *first* transoms are, referring to them in the rising order, below the *deck* transom. The *wing* transom is the sill of the gun-room ports; the *helm* transom is at the head of the stern-post and forms the head of the ports.

3. (*Ordnance.*) A horizontal piece connecting the cheeks of a gun-carriage.

4. (*Surveying.*) The vane of a cross-staff.

**Tran'som-knee.** (*Shipbuilding.*) A knee bolted to a transom and after-timber.

**Tran'som-win'dow.** (*Building.*) *a.* A window divided by a transom.

*b.* A window over the transom of a door.

**Trans-plant'er.** (*Agricultural.*) An implement for removing and transplanting flowers, bulbs, etc.

In *a*, the blades may be used separately for digging or stirring the earth, or pivoted together, to grasp the roots and lift them with a certain quantity of earth attached, without dropping the latter.

Fig. 6613.

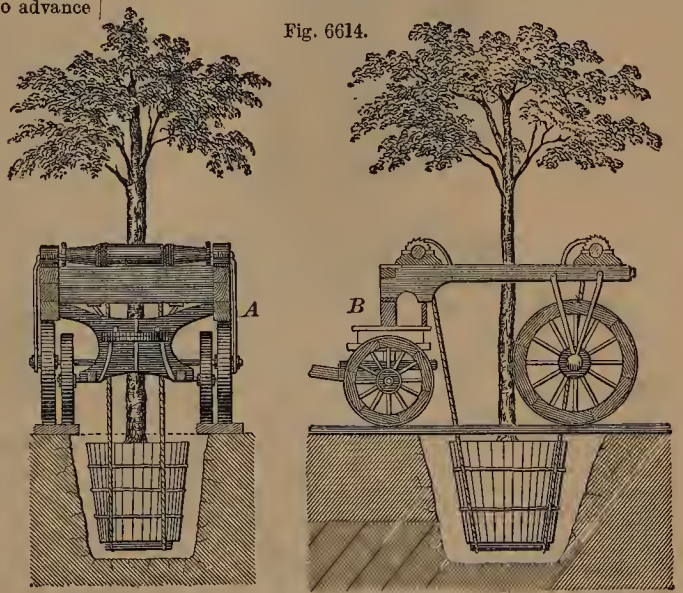
*Transplanting-Tools.*

*b* is a slight modification of the above; the handles are held together by the grasp of the hand or by a ring slipped over them. *c* is a root-puller.

**Trans-plant'ing-ap'pa-ra'tus.** A machine or truck for removing trees for replanting.

In Fig. 6614, *A* is an end and *B* a side elevation of a machine

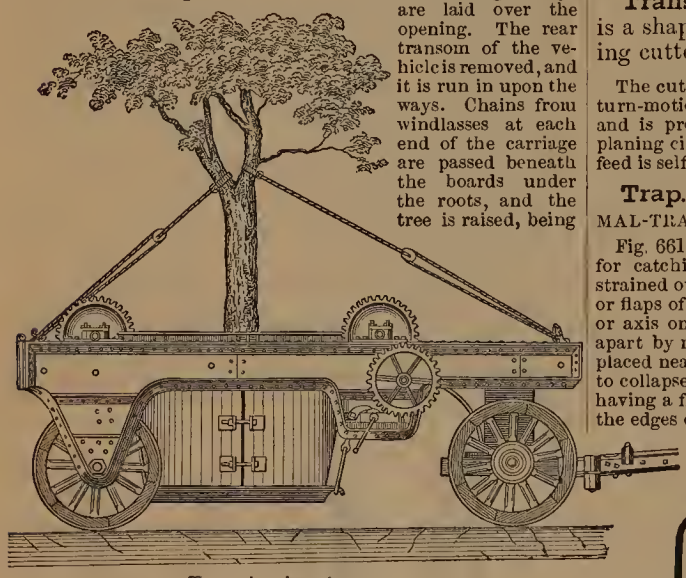
Fig. 6614.




*Transplanting-Apparatus.*

for transplanting small trees, and drawn by a single horse. A trench is dug around the roots of the tree, and the earth left around them is surrounded by branches of trees or staves which are secured by hoops or other suitable means. When a sufficient depth is attained the earth beneath is cut away and planks shoved under. Timbers serving for ways are laid over the opening. The rear transom of the vehicle is removed, and it is run in upon the ways. Chains from windlasses at each end of the carriage are passed beneath the boards under the roots, and the tree is raised, being

Fig. 6615.



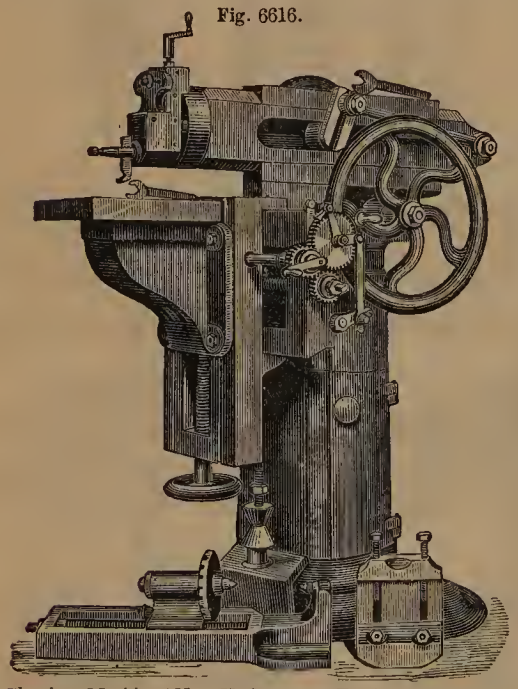
*Transplanting-Apparatus.*

steadied by guys if necessary; when raised clear of the ground it is conveyed to the spot where it is to be replanted.

Fig. 6615 is an apparatus of the same kind for removing larger trees, and requiring several horses.

These have been used in replanting the Bois de Boulogne, near Paris, which was nearly destroyed during the Franco-Prussian war of 1871.

Fig. 6616.



*Shaping-Machine (New York Steam-Engine Company).*

**Trans'port.** (*Nautical.*) A ship employed in the conveyance of troops or stores.

**Trans-verse' Plan'er.** 1. (*Wood-working.*) A planing-machine in which the cutters are caused to move across or at right angles to the material being planed. The usual practice is to adjust a rotating head or arms horizontally and parallel with the plane of the surface to be operated on, the table traveling in either direction under the head, thus bringing all parts of the material in contact with the cutters. See Fig. 3796, page 1728.

2. (*Metal.*) A shaper or planer with its cut transverse of the table. See next article; also Fig. 6150, page 2477.

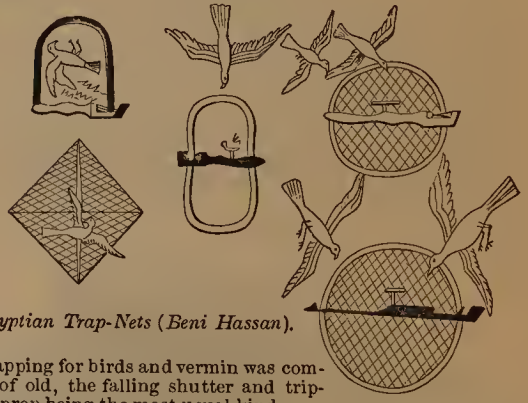
**Trans-verse' Shap'ing-ma-chine'.** Fig. 6616 is a shaping-machine with a horizontally reciprocating cutter-head on a pillar.

The cutting-bar has any stroke up to 8 inches, and quick return-motion. The table is moved up and down by a screw, and is provided with chuck, center, and vise. Apparatus for planing circular or any other form or shape is attached. The feed is self-operating or by hand. See also Fig. 6150, page 2477.

**Trap.** 1. A snare for animals. See also ANIMAL-TRAP.

Fig. 6617 illustrates traps in use among the ancient Egyptians for catching birds. They were generally made of network strained over a frame, and consisted of two semicircular sides or flaps of equal size, one or both moving on the common bar or axis on which they rested. When set the flaps were kept apart by means of strings which slipped aside when the bait placed near the center of the bar was touched, allowing the flaps to collapse and secure the bird. Another kind was square, having a framework running across the center and not around the edges of the trap like the first.

Fig. 6617.



*Egyptian Trap-Nets (Beni Hassan).*

Trapping for birds and vermin was common of old, the falling shutter and tripping-prop being the most usual kind.

The rabbits (*leberides*) of Spain were a great nuisance in the time of Strabo, destroying both seeds and trees by gnawing the roots. They infested Iberia, from Calpe to Marseilles, also the Gymnesian islands (Majorca and Minorca). The inhabitants of these islands petitioned the Romans for another land. They were eventually subdued by ferrets from Africa. (STRABO, Book III.)

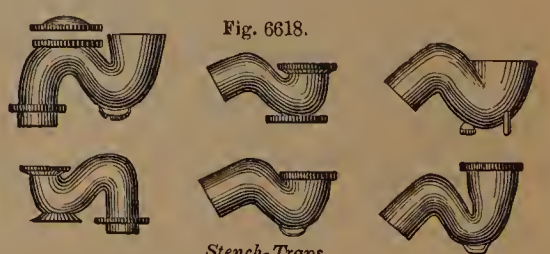
Pliny refers to similar instances of overrunning by animals, in Lib. VIII. chapter 29. The inhabitants of Abdera, in Thrace, were driven out of their town by rats and frogs, and settled on the frontiers of Macedonia. (JUSTIN, Lib. XV. chapter 2.)

Frogs annoyed the Egyptians once upon a time.

"At Casilinum (Nova Capua), 500 men of Præneste sustained against Hannibal, in the hight of his power, so desperate a siege, that, by reason of the famine, a rat was sold for 200 drachmee, the seller dying of hunger and the buyer surviving." — STRABO, Book V. chapter 4.

Cats are not mentioned in the canonical Bible, but were common in Egypt; they accompanied fowlers on their excursions, and were much revered. It was a capital crime to kill one. When they died they were embalmed, and buried at Bubastis. A cat is mentioned in the Apocrypha, and the animal is referred to by Herodotus.

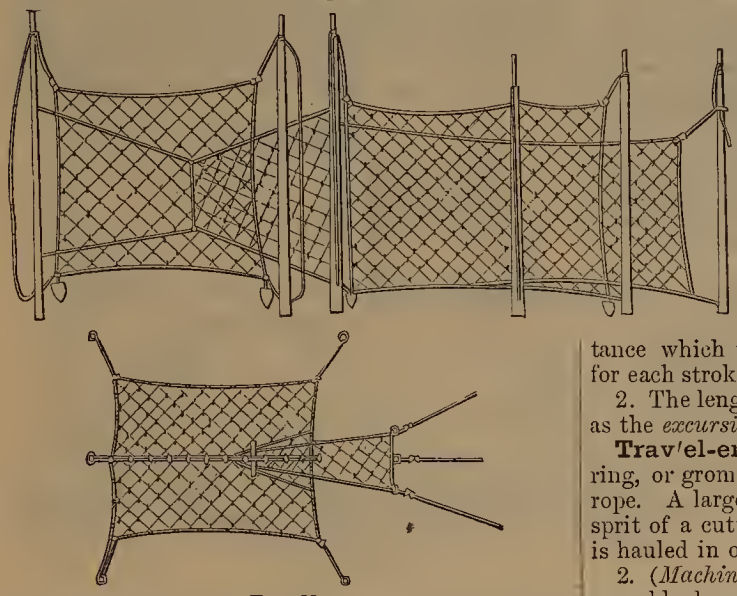
Fig. 6618.



*Stench-Traps.*

2. A sink or depression in a sewer-pipe to prevent passage of air.

Fig. 6619.



*Trap-Net.*

Fig. 6618 illustrates various forms of stench-traps for closet-pans.

A fish-trap and strainer consists of a detachable chamber, provided with a strainer, and isolated from the main, when required, by means of a stop-valve at each end. By this means cels, fish, and other matters which would choke the smaller service-pipes of a building are arrested, and when their presence is discovered may be removed by detaching the section and emptying it. It is useful in mains supplied from rivers and deficient in filtering arrangements.

See under the following : —

Animal-trap.
Bell-trap.
Bird-trap
Cruive.
Curculio-trap.
Fish-trap.
Fly-trap.
Insect-trap.
Man-trap.
Mole-trap.
Moth-trap.
Mouse-trap.
Rat-trap.
Sand-trap.
Shingle-trap.
Sink-trap.
Spring-trap.
Steam-trap.
Stench-trap.

3. A kind of movable step-ladder.

**Trap-cut.** A mode of cutting gems in which the facets consist of parallel planes, nearly rectangular, arranged round the center of the stone. See GEM.

**Trap-door.** A lifting or sliding door in a floor, roof, ceiling, or stage.

**Tra-peze'.** A swinging frame used by gymnasts in flying leaps and performing evolutions from a suspended pole.

**Trap'e-zoid'al Wall.** A retaining wall, vertical against the bank, and with a sloping face.

**Trap-net.** A fishing-net in which a funnel-shaped piece leads the fish into a pound from which extrication is not easy. The illustration shows an elevation and plan.

**Trap-stairs.** A stairs with trap-door at top.

**Trap-valve.** A valve hinged on one side of its seat, and opening and closing like a shutter or trap-door. A *clack-valve.*

**Trash.** (*Manege.*) A collar or leash to restrain a dog in coursing.

**Trass.** *Tarrass.* A volcanic earth, or calcareous tufa, resembling pozzuolana, and found in several districts of France and Germany, the theaters of extinct volcanic action ; the Vivarais, in the center of France ; at Brohl, near Andernach, on the Rhine. Like the hydraulic cement of Baiæ, it consists of ingredients which enable it to harden under water.

Beithier's analysis is as follows : —

| | *Trass.* | *Pozzuolana.* |
|---|---|---|
| Silica | 0.570 | 0.445 |
| Alumina | 0.120 | 0.150 |
| Lime | 0.026 | 0.088 |
| Magnesia | 0.010 | 0.047 |
| Oxide of iron | 0 050 | 0.120 |
| Potash | 0.070 | 0.014 |
| Soda | 0.010 | 0.040 |
| Water | 0.096 | 0.092 |
| | 0.952 | 0.996 |

**Trave.** (*Manege.*) A wooden frame or stocks to confine a horse or ox while shoeing.

**Trav'el.** 1. (*Steam.*) The distance which the slide-valve travels in one direction for each stroke of the piston.

2. The length of stroke of any object ; also known as the *excursion.*

**Trav'el-er.** 1. (*Nautical.*) An iron thimble, ring, or grommet adapted to slide on a bar, spar, or rope. A large ring of this kind is fitted on the bowsprit of a cutter, the jib tack is hooked to it, and it is hauled in or out to suit jibs of various sizes.

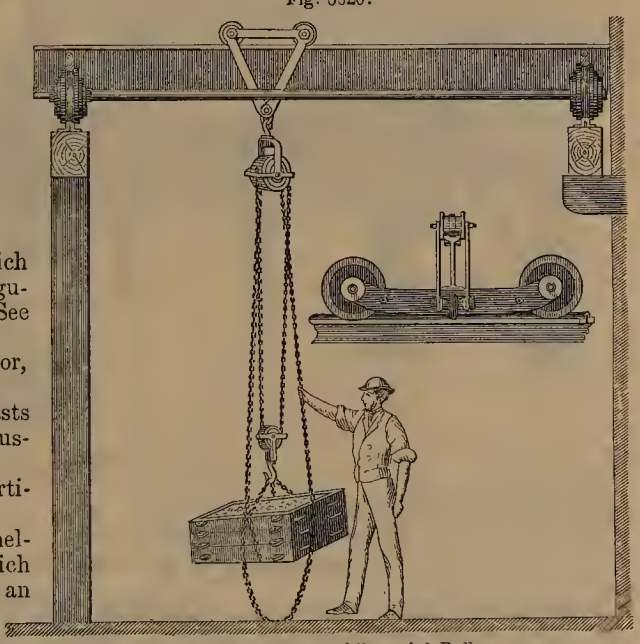
2. (*Machinery.*) A crab traversing on an elevated movable beam, supported on framework ; it is intended for raising heavy loads and moving them from place to place in a workshop. Fig. 6620.

3. (*Spinning.*) A small open ring or metallic loop placed about the race of a ring, used in ring spinning-frames.

The yarn passes from the delivering rollers to and through the traveler and then to the bobbin.

The cut shows a ring and traveler applied to a Sawyer spindle, — an American invention, now being largely introduced ;

Fig. 6620.



*Traveler, with Differential Pulley.*

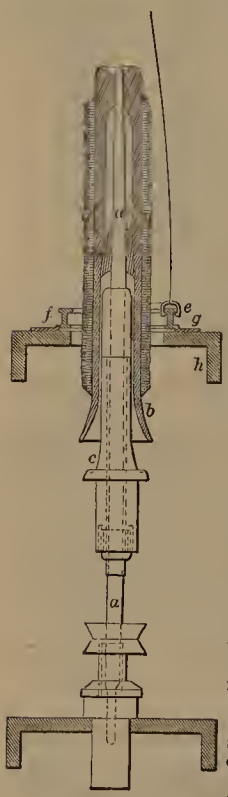
650,000 of them in the last two or three years. It is run at a higher rate of speed, doing more and better work, with less power, than the ordinary spindle used in ring frames. The spindle is supported only at the bottom and at a point much nearer the top of the bobbin than usual. The spindle is steadied nearer its upper end, and prevented from vibrating, permitting the spindle to be made much lighter and shorter than usual.

The spindle *a* is sustained within the bobbin *b*, by the upper end of the elongated bushing *c*, supported, as usual, in the bushing rail of the frame.

The yarn is represented at *d*, the traveler at *e*, the ring at *f*, the holder at *g*, and the movable ring-rail at *h*.

The spindle and the bobbin, held to it by friction, rotate and twist the thread extending from the bobbin through the

Fig. 6621.




*Sawyer's Spindle, with Ring and Traveler.*

traveler, and the latter, held back owing to its friction on the race of the ring, detains the yarn and enables the spindle to revolve on its axis oftener than the traveler revolves on the race about the spindle; and this excess of motion on the part of the spindle enables the spun yarn to be wound on the spindle-bobbin.

The ring has a double race, so that it may be reversed when worn, and it is confined to the ring-rail by an adjustable holder that permits this ring to be set exactly concentric with the spindle.

**Trav'el-ing-bag.** A satchel or carpet-bag.

**Trav'el-ing-belt Pro-pel'ler.** (*Marine.*) A form of propeller in which a belt traverses over twin-wheels.

**Trav'el-ing-crane.** A crab for lifting weights, fixed on a truck which moves on rails, on top of a frame or building.

Among the earliest examples of this kind are those designed by Rennie for the mahogany sheds at the West India Dock, London. These move in one direction only, and are used for piling away the logs of timber.

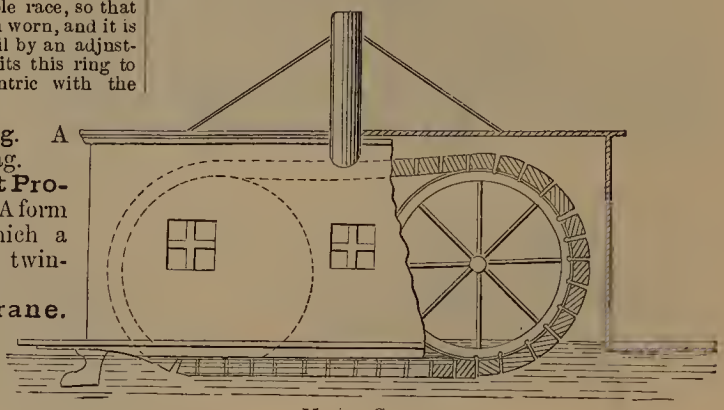
A subsequent improvement was to support the frame on which the crab or carriage travels, upon rollers, so that it has a movement at right angles to that of the crab.

Fig. 6623.

Fig. 6623 represents an overhead steam-crane. The engine, instead of being stationary at one end of the *gantry*, is mounted on the carriage and travels with it.

The engine is fitted with single and double purchase-blocks, link motion for reversing, strap-brake, with foot-lever and pawl to hold the load suspended when required; the longitudinal and transverse traveling motions are driven by sets of friction-clutches, so that without stopping or reversing the engine the load may be lifted and traversed longitudinally and transversely

Fig. 6622.

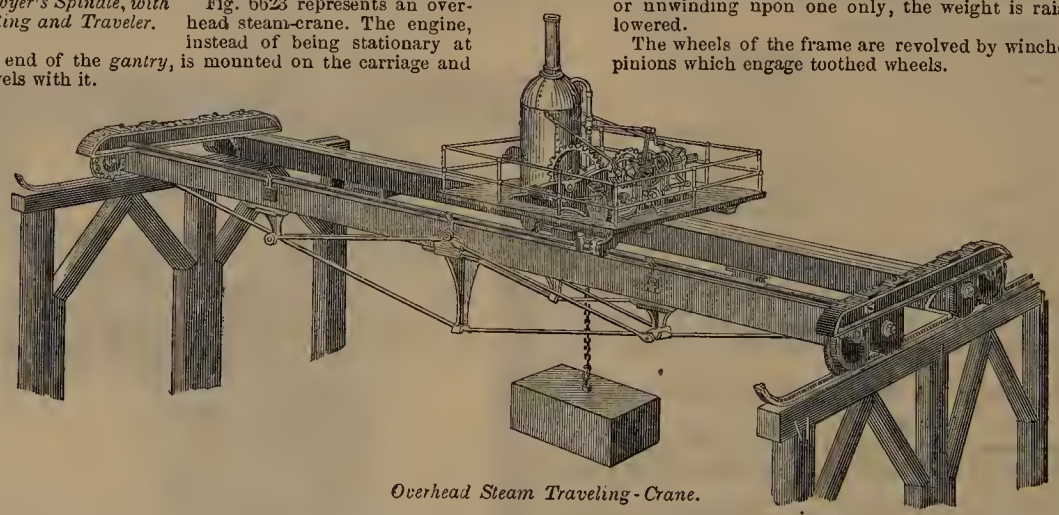


*Marine Car.*

at the same time. The levers are all controlled by a single operator.

Fig. 6624 illustrates an arrangement of this kind. Two triangular frames are mounted on wheels which run upon rails and support two parallel beams; on these is laid a railway, upon which the carriage containing the pulleys for the chain traverses; the ends of the chain pass along and above the beams to fixed pulleys at each end, and thence down to the winches at the bases of the frames. By winding upon one of these winches, and unwinding from the other, the carriage is traversed from side to side; by winding or unwinding upon one only, the weight is raised or lowered.

The wheels of the frame are revolved by winches and pinions which engage toothed wheels.



*Overhead Steam Traveling-Crane.*

**Trav'el-ing-der'rick.** One mounted on a carriage. (See TRAVELING-CRANE.) The crane differs from the derrick in the construction of the frame. See CRANE; DERRICK.

**Trav'el-ing-forge.** The wagon, with its tools and stores, which accompanies a battery of field-artillery for the purpose of repairs. See BATTERY-FORGE.

**Trav'ers.** A skeleton-frame which holds the bobbins of yarn, which are wound therefrom on to the warp-frame. See WARPING-MILL.

**Trav'erse.** 1. (*Fortification.*) A short embankment of earth thrown up to intercept an enfilading fire. They are placed on the terreplein, between the guns on the banquette, in the covered way, before the door of a magazine, or wherever there is room and their protection is necessary. See BASTION.

2. (*Ordnance.*) The horizontal sweep of a gun to command different points.

3. A barrier or sliding-screen.

4. (*Architecture.*) An elevated gallery or communicating loft in a building.

5. (*Nautical.*) *a.* The zigzag course of a ship.

*b.* To brace a yard aft.

6. (*Carpentry.*) To plane across the grain of a board.

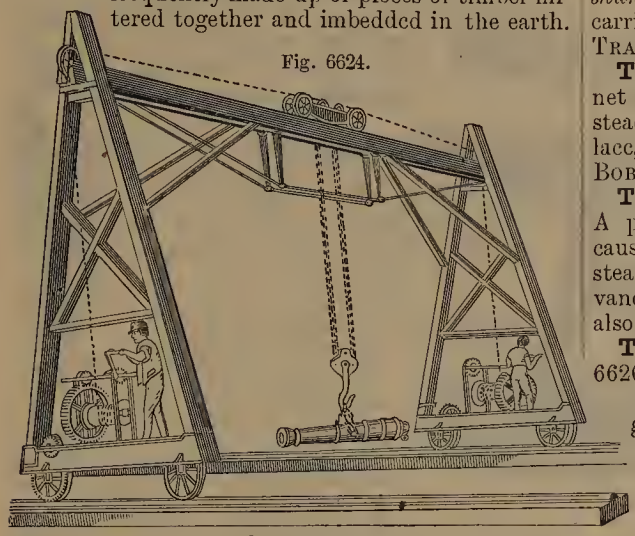
**Trav'erse-board.** (*Nautical.*) A circular board marked with the compass-points, and having holes and pegs to indicate the course by which the ship has been sailing.

It is used for recording the courses run during a watch.

**Trav'erse-cir'cle.** 1. (*Fortification.*) A circular track on which the chassis traverse-wheels of a barbette carriage, mounted with a center or rear pintle, run while the gun is being pointed; the arrangement enabling it to be directed to any point of the horizon. In permanent fortifications it is of iron,

and is let into the stone-work; in field-works it is frequently made up of pieces of timber mitered together and imbedded in the earth.

Fig. 6624.



*Ordnance-Crane.*

2. (*Nautical.*) A metallic circle let into the upper deck of a war-vessel for the wheels of a pivot-gun carriage to traverse on.

**Trav'erse-drill.** 1. A drill for boring slots. It or the work has a lateral motion after the depth is attained.

2. One in which the drill-stock has a traverse-motion for adjustment, as in the figure following.

The machine (Fig. 6625) is specially adapted for drilling the pin-holes at both ends of links for suspension-bridges at the same time, so as to secure perfect uniformity in the distance between them. The standards *a a* which support the boring-apparatus slide in the bed *b*, enabling them to be adjusted to the required length. The links are put in place on one side of the machine, and when done removed at the other. The driving is effected by horizontal belts passing over guide-pulleys and around a drum on the spindles.

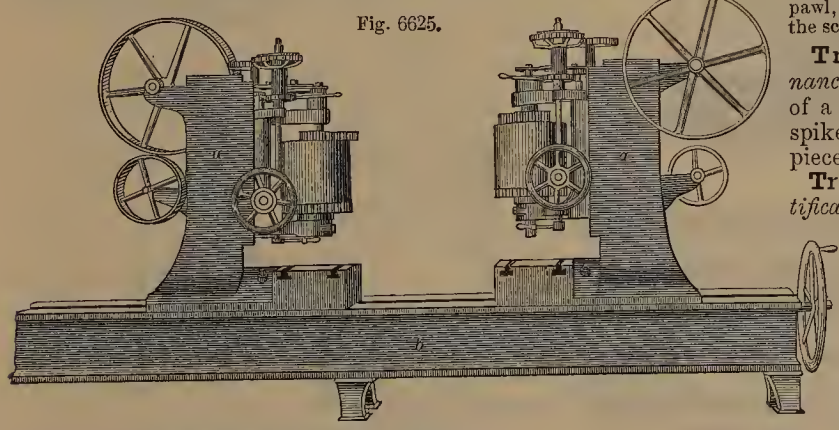
**Trav'ers-er.** (*Railway Engineering.*) A device to shift a railway car or locomotive from one line of rails to another line parallel thereto. It is a platform supporting a section of the line of rails, and supported on wheels, which traverse on a transverse line of rails at a lower level.

**Trav'erse-saw.** A cross-cutting saw which moves on ways across the piece (Fig. 6626).

**Trav'erse-ta'ble.** 1. (*Nautical.*) A table by means of which the difference of latitude and departure corresponding to any given course and distance may be found by inspection.

It contains the lengths of the two sides of a right-angled triangle, usually for every quarter of a degree of angle, and for all lengths of the hypotenuse from 1 to 100.

Fig. 6625.



*Double Traverse-Drill.*

2. (*Railway.*) A platform on which cars are *shunted* from one track to another in a station, being carried across instead of run out and *switched*. See TRAVERSER.

**Trav'erse-warp Ma-chine'.** A form of bobbinet machine, so called from the warp traversing instead of the carriages. Principally used for spotted lace, blond edging, and imitation thread laces. See BOBBINET; LACE.

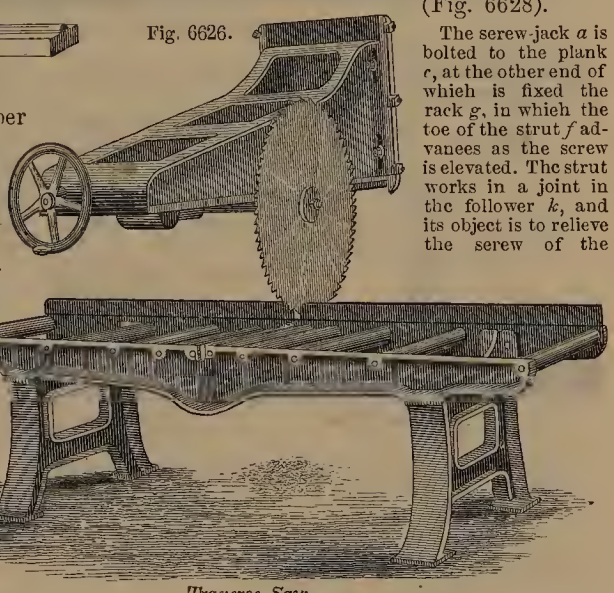
**Trav'ers-ing-bed Plan'er.** (*Wood-working.*) A planer in which the bed carrying the work is caused to traverse beneath the revolving cutters, instead, as is usually the case, of the work being advanced over the stationary table (Fig. 6627). See also PLANING-MACHINE, Fig. 3796, page 1728.

**Trav'ers-ing-el'e-va'tor.** See TRAVELER, Fig. 6620; and HAY-ELEVATOR, Fig. 2449.

**Trav'ers-ing-jack.** *a.* A jack used for engines or carriages upon the rails.

It is adapted for raising and then drawing (Fig. 6628).

Fig. 6626.



*Traverse-Saw.*

The screw-jack *a* is bolted to the plank *c*, at the other end of which is fixed the rack *g*, in which the toe of the strut *f* advances as the screw is elevated. The strut works in a joint in the follower *k*, and its object is to relieve the screw of the violent cross strain when the load is drawn forward on the sill-piece *d* by the vibration of the lever, which has its fulcrum in the rack *h*, and engages by its horn with the link *i* on the plank *c*.

*b.* A lifting-apparatus, the standard of which has a movement on its bed, enabling it to be applied to different parts of an object or used for shifting objects horizontally without moving the bed.

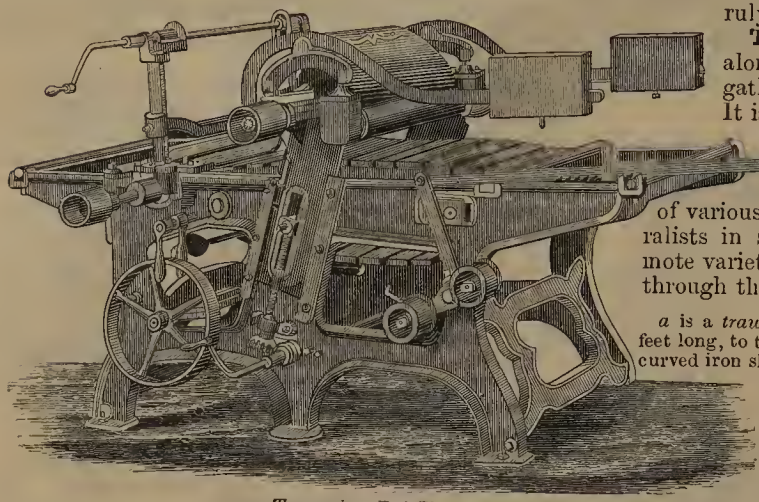
In that illustrated (Fig. 6629), the lifting movement is effected by hydraulic power, and the traverse is imparted by means of a screw passing through a nut in the foot of the standard, and turned by a lever provided with a pawl, which turns a ratchet on the end of the screw-shaft.

**Trav'ers-ing-plate.** (*Ordnance.*) A plate at the hinder part of a gun-carriage where the handspike is applied to traversing the piece.

**Trav'ers-ing-plat'form.** (*Fortification.*) A platform provided for guns which are pivoted so as to sweep the horizon, or a part of it.

The chassis has a pintle in front, and the rear portion has wheels, which traverse a curved track as the gun and its chassis are moved around by handspikes.

Fig. 6627.

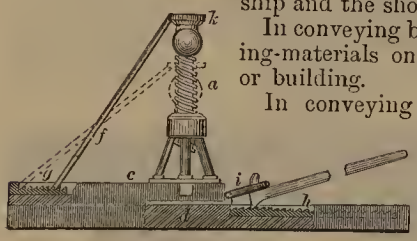


*Traversing-Bed Planer.*

**Trav'ers-ing-pul'ley.** A pulley so arranged as to traverse upon a rope or rod.

It is used in communicating by a rope between a stranded ship and the shore.

Fig. 6628.



*Traversing-Jack.*

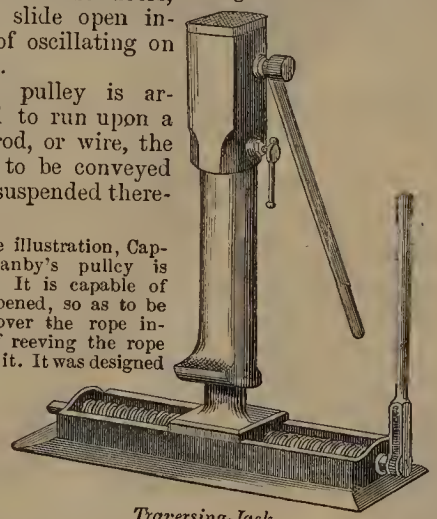
In conveying bricks or building-materials on to a scaffold or building.

In conveying freight upon a track wire (see WIRE-ROAD), — a mode which has lately come into use.

In conveying to a part of the barn or mow a load of hay lifted by a horse hay-fork. See HOISTING-MACHINE.

In supporting barn and warehouse doors, which slide open instead of oscillating on hinges.

Fig. 6629.



*Traversing-Jack.*

The pulley is arranged to run upon a rope, rod, or wire, the object to be conveyed being suspended therefrom.

In the illustration, Captain Manby's pulley is shown. It is capable of being opened, so as to be placed over the rope instead of reeving the rope through it. It was designed for the Captain's life-saving apparatus, in which a cradle is made to traverse on a rope stretched between a stranded ship and the shore.

In cases where the pulley is not liable to be unshipped, the pulley-block may have one cheek cut away like a snatch-block, to allow it to be placed in running order upon the rope.

**Trav'ers-ing Screw-jack.** See TRAVERSING-JACK.

**Trav'er-tine.** A calcareous tufa, used for building; also ground to form a hydraulic cement.

**Trav'is.** A confining frame for unruly horses while shoeing.

**Trawl.** A net dragged along the sea-bottom to gather forms of marine life. It is a dredge, and is made of heavy and coarse materials for oystermen, and of various kinds and sizes for naturalists in search of the more remote varieties of "all that passeth through the paths of the sea."

Fig. 6630.

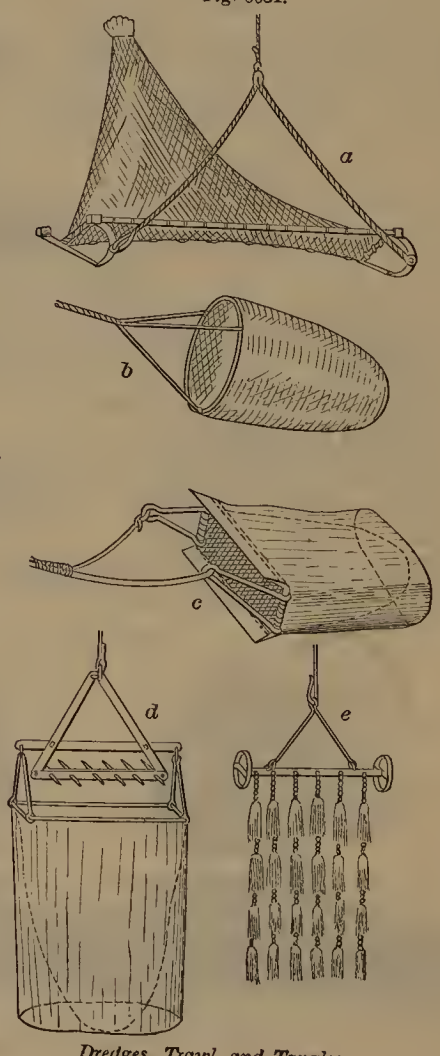
*Traversing-Pulley.*

*a* is a *trawl* with a beam ten or twelve feet long, to the ends of which are affixed curved iron shoes or runners. From it depends a funnel-shaped net of perhaps thirty feet in depth, weighted by a string of leads on the forward lower edge. These weights and that of the runners are sufficient to sink the trawl, and it does not usually need an extra weight in front, on the drag-rope, as does the dredge. Projections or webs proceeding from the inside of the net, called pockets, serve to prevent fishes captured in the net from getting out by the route that they go in.

*b* is a *bag-net* with distending hoop, used for catching floating creatures.

*c* is a *dredge*, the front of which is a rectangular frame of iron, about two feet by eight inches, the long sides extending forward as scrapers, the short sides furnishing points of attachment for handles. This frame forms the mouth of a fine meshed net about four feet long. Over the net a canvas bag, open at the bottom, is extended, which serves to protect the

Fig. 6631.




*Dredges, Trawl, and Tangles.*

net from injury while it is dragged over the rocks. To bring the scrapers down to their work, a weight of about 20 pounds is fastened on the drag-rope about one or two yards in advance of the dredge. The drag-rope is tied directly to one of the handles, but is attached to the other only by a light line.

The open iron frame acts as a scraper, and lifts from their bed all the strange forms of life that adhere to the bottom; they are simply scraped up by this contrivance, and, with a great quantity of mud, are caught in the net behind the frame.

*d* is the *rake-dredge*, whose mouth is preceded by an iron bar parallel with it, and bearing a set of sharp-pointed teeth capable of tearing up Neptune's stubbornest glebe. The "rake" is essentially a harrow; its especial use is in the case of bottoms of very tough mud or clay, where it is desirable to unearth the animals which are partly imbedded. Such bottoms are also frequently so serrated with the tough tubes of marine worms as to make the work of the ordinary dredge unsatisfactory: the rake-dredge readily tears through these tubes.

*e* are *tangles* or mops of hemp attached by chains to a bar which has runners and a towing cord. The *tangles* are used to catch small, delicate, or spinaccous forms of marine life. See TANGLES.

**Trawl-boat.** (*Nautical.*) One used in fishing with trawl-nets.

**Trawl-net.** See TRAWL.

Fig. 6632.

*Trawl-Roller.*

**Trawl-roll'er.** A roller having a number of grooves cut in its periphery, and attached to the side of the wherry or dory, and over which the trawls are drawn into the boat.

**Trawl-warp.** A rope passing through a block and used in dragging a trawl-net.

**Tray.** A flat receptacle for handing glasses, dishes, and what not. Known by names indicating *material* or *purpose*, as

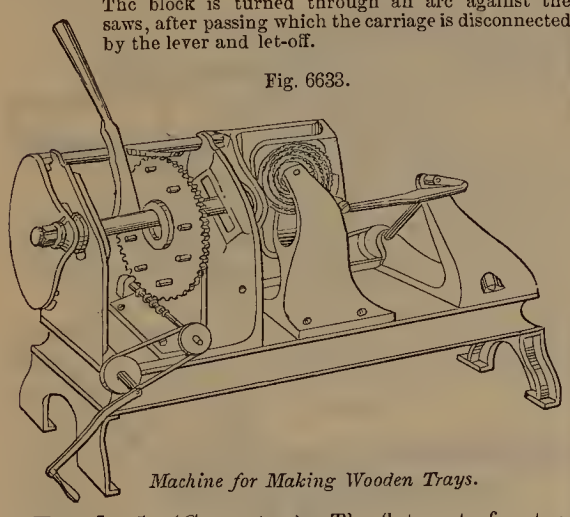
| | |
|---|---|
| Papier-maché. | Tea. |
| Tin. | Bread. |
| Silver. | |

Also known as a *waiter*, or *salver*.

The κιστη δειπνοφορος was the Greek dinner-tray.

Fig. 6633 is a machine for making oval trays or bowls of wood. The block to be cut into trays being secured to the carriage when in a horizontal position, the lever is placed against the wheel so that one of the pins thereon will catch it as the wheel revolves. As the pin strikes the lever, the carriage is started, and guided by the ends of the guide-pin in guide-way grooves. The block is turned through an arc against the saws, after passing which the carriage is disconnected by the lever and let-off.

Fig. 6633.



*Machine for Making Wooden Trays.*

**Tread.** 1. (*Carpentry.*) The flat part of a step. The vertical part is the *riser*.

2. (*Shipwrighting.*) The length of a ship's keel.

3. (*Vehicle.*) *a.* The bearing surface of the runners of a sled.

*b.* The bearing surface of a wheel.

4. (*Lathe.*) The upper surface of the bed between the headstock and the back center.

5. That part of the sole of a boot or shoe which touches the ground in walking.

6. (*Fortification.*) The top of the banquette, on which the soldiers stand to fire.

7. (*Railway.*) *a.* The part of a car-wheel which bears upon the rail.

*b.* The part of a rail upon which the wheels bear.

**Tread'le.** (*Machinery.*) A foot-lever connected by a rod to a crank to give motion to a lathe, sewing-machine, circular saw, or other small mechanism.

In Stewart's adjustable treadle for sewing-machines, the center of motion of the foot and the axis of the treadle coincide. There is scarcely any motion of the knee.

A *treadle* is distinct from a *pedal*, whose use is in musical instruments to raise a damper, open a valve, work a bellows, or what not, and is not designed to produce a rotary motion.

**Tread-mill.** A wheel driven by the weight of persons treading upon the steps of the periphery. It is usually employed in prisons, where it forms the "hard labor" of persons convicted of crime.

The usual form is a wheel 16 feet long and 5 in diameter, several such wheels being coupled together when necessary for the *accommodation* of the prisoners. The circumference of each has 24 equidistant steps. Each prisoner works in a separate compartment, and has the benefit of a hand-rail.

The wheel makes two revolutions per minute, which is equivalent to a vertical ascent of 32 feet. The power may be utilized in grinding grain or turning machinery.

The tread-mill is a feature of English prison discipline, and sometimes is not revolved to any useful effect, a brake being simply attached to the axle, forming a seat for the overseer, who graduates the work or speed by moving toward or from the outer end of the lever.

Our transatlantic cousins have an idea, their surplus of labor being so great, that it is poor economy to make prisoners work to any useful end, as it takes employment from the hands of workmen outside, and sets them to stealing, or sends them to the poor-house. The same idea is becoming current here. "There is something rotten in the state of (Denmark?)"

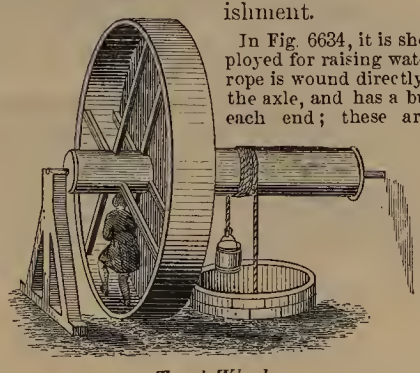
It need hardly be said that the labor comes rather unevenly upon the sick and the well, the weaver and the plowman, the fat and the lean, he that is "as subject to heat as butter, a man of continual dissolution and thaw," and he that "has a lean and hungry look." See TREAD-WHEEL.

The tread-mill was a Roman institution, and was used for raising water by the work of condemned criminals.

The Chinese also use it to irrigate lands. It was introduced into England as a means of prison discipline by Cubitt, 1817.

**Tread-wheel.** A wheel turned by men or animals, either by climbing or pushing with the feet. The tread-mill, formerly used as a means of punishment.

Fig. 6634.



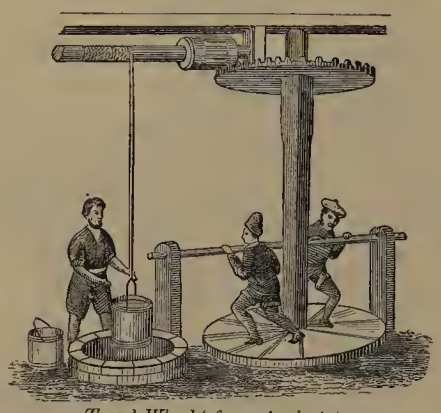
*Tread-Wheel.*

In Fig. 6634, it is shown employed for raising water. The rope is wound directly around the axle, and has a bucket at each end; these are alternately raised and lowered by reversing the movement of the wheel.

In Fig. 6635, from Agricola, also a water-raising device, the wheel is horizontal, and turned by pushing. A crown-wheel and rundle are interposed to rotate the axle carrying the bucket-rope. Agricola (Ger. *Bauer*, peasant) died at Chemnitz, 1555.

A form of tread-wheel in which animals walk inside of a large wheel is used in pumping from the deep well of Carisbrook Castle, England; turn-spit dogs were formerly used in turning the spit upon which meat is roasting; and dogs are employed in some dairies to turn the barrel-churns or agitate the vertical dashers of plunger-churns.

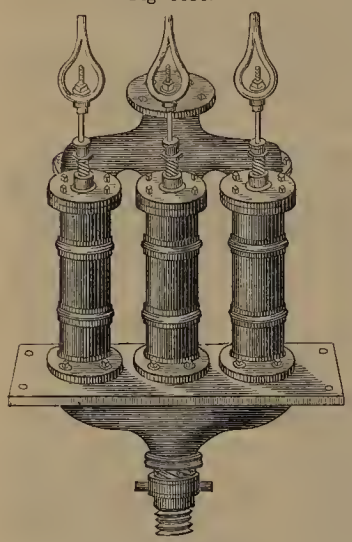
Fig. 6635.



*Tread-Wheel (from Agricola).*

**Treb'le-bar'rel Pump.** A pump having three barrels connected with a common suction-pipe. The pistons are operated by a three-throw crank, the cranks being set at angles of 120°, so that each piston is always at a different part of the stroke from either of the others, and a continuous flow produced.

Fig 6636.



*Treble-Barrel Pump.*

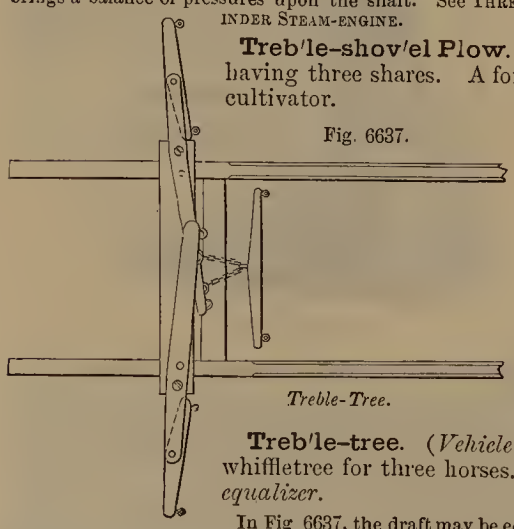
**Treb'le-block.** (*Nautical.*) A block with three sheaves; ordinarily used as a purchase-block.

**Treb'le-cyl'inder Steam-en'gine.** (*Steam.*) An engine having a pair of large cylinders for the continuation of the expansion, one at each side of the small cylinder.

In the usual arrangement, the piston of the central small cylinder drives one crank, and those of the two lateral large cylinders drive a pair of cranks pointing the opposite way to the middle crank. Half the work being performed by the middle cylinder, and the other half being equally divided between the lateral cylinders, brings a balance of pressures upon the shaft. See THREE-CYLINDER STEAM-ENGINE.

**Treb'le-shov'el Plow.** One having three shares. A form of cultivator.

Fig. 6637.

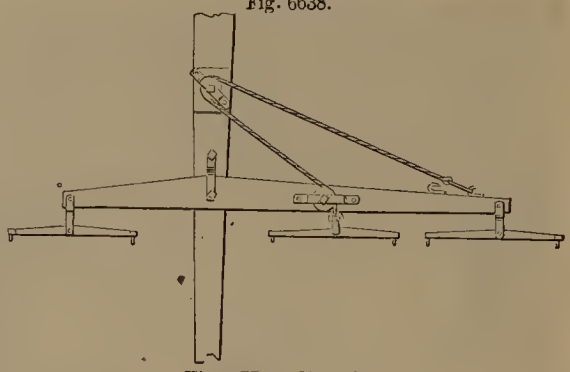


*Treble-Tree.*

**Treb'le-tree.** (*Vehicle.*) A whiffletree for three horses. An *equalizer*.

In Fig 6637, the draft may be equally apportioned among the three horses if they are of equal energy and strength, but either of the outside horses may be favored by shifting the pivot-bolt of its double-tree.

Fig. 6638.



*Three-Horse Equalizer.*

In Fig 6638, the third whiffletree is attached to a cord which runs around pulleys on the splinter-bar and tongue, and connects to the long end of the splinter-bar, to equalize the draft on its two ends.

**Tre'buck-et.** 1. A warlike engine formerly used for hurling stones. A heavy weight on the short end of a lever was suddenly released, raising the light end of the longer arm containing the missile, and discharging it with great rapidity.

2. A kind of balance used in weighing.

**Tre-chom'e-ter.** An odometer for vehicles.

**Tree.** A generic name for many wooden pieces in machines or structures.

1. (*Vehicle.*) *a.* The bar on which the horse or horses pull, as *single*, *double*, *treble*, *whiffle*, *swingle* trees.

*b.* The *axle;* also known as an *axletree.*

2. (*Harness.*) The frame for a saddle; a *saddle*-tree, *harness*-tree, *gig*-tree.

3. (*Shipbuilding.*) A bar or beam in a ship, as *chess*-tree, *cross*-tree, *rough*-tree, *trestle*-tree, *waste*-tree (which see).

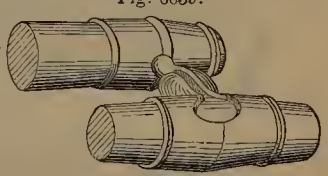
4. (*Milling.*) The bar supporting a mill-spindle. See *f*, Plate XXII. G.

5. A frame on which a boot-leg is distended; a *boot*-tree.

**Tree-coup'ling.** A piece uniting a *single* to a *double* tree.

In Fig 6639, a ball is introduced through an opening in the thimble which clasps the mid-length of the single-tree and then takes its seat in the frustum of a sphere which forms the other portion of the universal joint. The neck is attached to the double-tree.

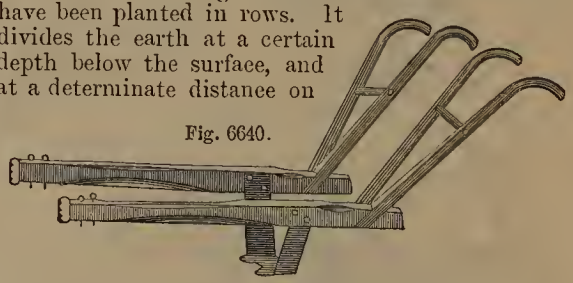
Fig. 6639.



*Tree-Coupling.*

**Tree-dig'ger.** (*Agricultural.*) A kind of double plow employed in nurseries for cutting off the roots of trees which have been planted in rows. It divides the earth at a certain depth below the surface, and at a determinate distance on each side of the rows, to permit the tree to be readily removed from the soil.

Fig. 6640.



*Tree-Digger.*

**Tree-ir'ons.** (*Vehicle.*) The irons connecting single to double trees, or the latter to the tongue of

the vehicle. Also the hooks or clips by which the traces are attached.

**Tree'nail.** (*Shipbuilding.*) A cylindrical pin of hard wood used for securing planking to the frames, or parts to each other. Teak (*Tectona grandis*), a tree of India and Burmah, is much esteemed for this purpose, as it shrinks little and has no acrid juices to rust bolts. Oak is also much used.

Treenails are from 1 to 1¾ inches in diameter.

Compressed treenails are made by driving the steamed treenail through a tapering steel tube, so as to reduce them to ⅔ of their original diameter.

The original words mean *wooden nail.* (Old English, *treen*, wooden.)

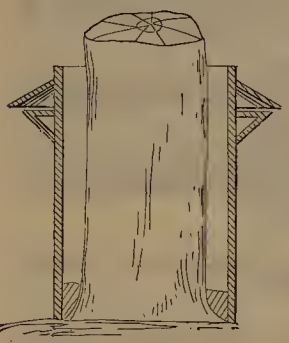
They are tightened by wedges driven into each extremity.

**Tree-pro-tect'or.** A device put around a tree to deter insects which crawl up the tree and bark.

Various means are tried, especially to stop the curculio (*Conotrachelus nenuphar*), a particularly energetic nuisance.

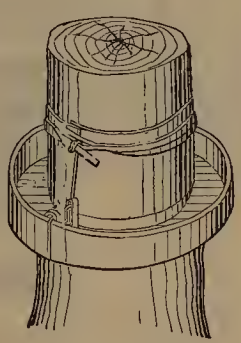
Fig. 6641 has a fluid-containing trough, situated at the upper end of a tubular support which rests upon the ground at its base.

Fig. 6641.



*Tree-Protector.*

Fig. 6642.



*Tree-Protector.*

Fig. 6642 has a pair of semi-annular troughs, united by clamps so as to embrace the tree, to which it is slung by a flexible band.

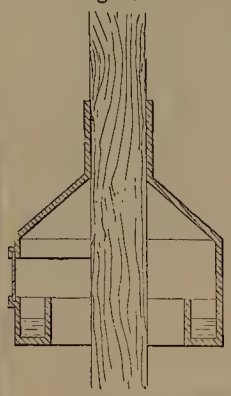
Fig. 6643 has a suspended trough, also full of water.

Fig. 6644 has a pair of frustums which together form a trap and trough.

**Tree-re-mov'er.** A truck used for transplanting trees of considerable size. It is so constructed as to be readily taken apart and put together, so that it may be brought centrally over the roots of the tree with its frame surrounding the trunk, and is provided with ten sling-chains for raising the temporary platform placed beneath the roots, by which the tree is lifted out of the ground.

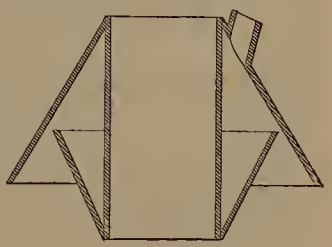
A circular trench is dug sufficiently wide and deep to include the roots, and within this circle the earth is carefully removed, leaving a quadrangular mass, as shown below, somewhat longer than broad. Beneath this in a longitudinal direction a trench is dug to receive two stout poles *a*, over which is placed a stout plank *b*. A strong chain is then passed over the poles at each end, and by means of the screw-jack at the front of the carriage the poles and board are lifted so that the latter bears against the bottom of the clod of earth. Two channels are then cut at the ends to receive the boards *c c*, and two others at the sides for the boards *d d*. Litter is then stuffed in with a spade between the planks and the soil, so that it may have a firm bearing on the platform when raised. Guy-ropes are attached to a collar as high upon the tree as practicable, and the tree with the mass of earth attached to the roots is lifted clear of the ground by turning the jack-screw. It is then conveyed to the spot where a pit has been prepared to receive it, is lowered into place, and the carriage taken apart and removed. The pieces composing the platform are then withdrawn, the necessary filling in with earth around the roots done, and guys carried out and attached to pieces of wood buried in the earth, or in other convenient manner, if necessary for the temporary support of the tree. A smaller machine of the kind has but one front wheel, and is operated by a lever and ratchet windlass. See also TRANSPLANTING APPARATUS.

Fig. 6643.



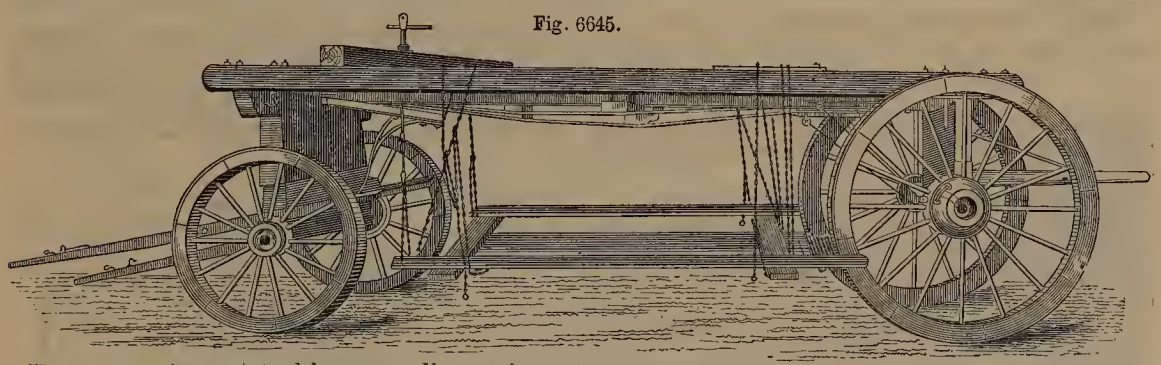
*Tree-Protector.*

Fig. 6644.



*Tree-Protector.*

Fig. 6645.



**Tree-scrap'er.** A tool hare, usually a triangular blade, to remove old bark and moss from trees. Also used in gathering turpentine.

**Tref'le.** (*Fortification.*) A mine with three chambers, like a *trefoil.*

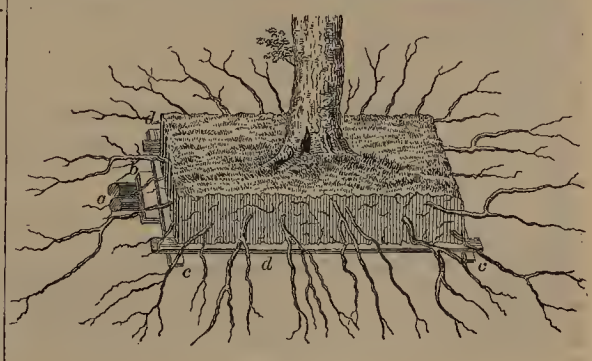
**Treil'lage.** (*Husbandry.*) A light frame of posts and rails to support espaliers. A *trellis.*

**Treil'lis.** A coarse kind of quilted linen.

**Trel'lis.** 1. A gate or screen of open-work; lattice-work either of metal or wood.

2. (*Husbandry.*) A support for vines, creepers, or espaliers. Used especially for grapes, hops, and ornamental climbing-plants.

Structurally, they may be posts or poles, isolated, grouped, or connected by wires or slats, — poles with branches or with fan-shaped or pyramidal tops; posts with wires on horizontal




*Tree-Remover.*

slats, and resembling fences or walls; screens or walls of slats, or wires forming panels of network between posts; devices consisting of arbors, covered paths, or extended overhead network, forming a ceiling of vine-supporting trellis; arrangements of posts and slats for espalier apple, cherry, pear, quince, or for other trees, known in England as *wall-fruit*, from the fact that such are nailed fan-wise against walls to conserve the heat and enable the fruit to ripen in a latitude north of Quebec. Such trees are the apricot, peach, and nectarine, most of which, if not all, came from Persia.

Smaller trellises, for garden work, are network frames, for tomatoes, peas, and many ornamental climbers; cylindrical, pyramidal, columnar, or fan-like trellises for climbers.

Special devices are formed for permanent ground-sockets with shifting poles. For upper structures, hinged so as to be laid down on the ground to be covered up with matting or straw for winter protection of tender grapes, or covered with earth as practiced by General Worthington of Chillicothe, Ohio, with his fig-trees. Other devices are for anchoring posts, or staying them with guys, or straining the wires of the trellis; guards to keep insects from climbing posts; claw bars and jacks for pulling posts and poles.

The devices are numerous in each specific line, and we must be content with this mere hint of the direction of invention.

**Tre'loob-ing.** (*Mining.*) See TOSSING.

**Trem'o-lo.** (*Music.*) A pulsative tone in a wind instrument produced by a variation in the volume of air admitted from the bellows. It is produced by a fluttering valve which commands the air-duct.

**Tre'nail.** A wooden pin employed in certain situations in preference to iron or copper bolts. See TREENAIL.

**Trench.** 1. (*Fortification.*) An excavation to cover the advance of a besieging force. It generally proceeds in a zigzag form, connecting the parallels and advanced batteries, and is 6 to 10 feet wide, 3 feet deep, the earth excavated forming a parapet on the side exposed to the fire of the fortress. 70 miles of trenches were excavated at Sevastopol. See APPROACH; ZIGZAG.

The approach to fortified places by *trenches* or *parallels* was used by Mahomet II. They were mentioned, however, by Cæsar in the siege of Marseilles; by Diodorus Siculus in that of Ægina; by Livy; and are represented on the column of Trajan and arch of Severus.

2. A ditch for drainage.

**Trench-cart.** (*Fortification.*) A cart adapted to traverse the trenches with ordnance, stores, and ammunition.

**Trench-cav-a-lier'.** (*Fortification.*) A high parapet made by the besiegers upon the glacis to command and enfilade the covered way of the fortress.

**Trench'er.** A wooden platter. The *quadra* of the Romans. Made of sycamore or maple. The *cissorium* of the Middle Ages.

**Trench-plow.** A *ditching-plow.*

**Trend.** 1. (*Nautical.*) *a.* The thickening of an anchor *shank* as it approaches the *arms.* It extends upward from the *throat* a distance equal to the length of the *arm.*

*b.* The angle formed by the line of a ship's keel and the direction of the anchor-cable.

2. (*Fortification.*) The general line of direction of the side of a work or a line of works.

**Tre-pan'.** 1. (*Surgical.*) A crown saw used principally in removing portions of the skull. The *trephine* is an improved form. See TREPHINE.

One boring instrument of the Romans was the *trypanon*, whence our name *trepan.* Whether it was really a crown-saw does not clearly appear.

2. (French.) A workman's name for the steel at the foot of a boring rod. *Trepang.*

A trepan in the Belgian section of Machinery Hall, Centennial Exhibition, Philadelphia, 1876, was 10 feet in length of face, and weighed 10 tons. It was rotated 6 inches after each stroke, and dug a hole 10 feet in diameter. Sand buckets and claws removed the mud and large stones from time to time; the instrument being intended to work in water and dispense with a caisson. A second reamer, 15 feet face and weighing 15 tons, followed the former to enlarge the hole, which was then tubed with cast-iron sections.

**Tre-pan'ning.** (*Brush-making.*) The tufts or bristles are drawn into the holes in the stock by means of wire inserted through holes in the edge, which are then plugged, concealing the mode of operation.

**Tre-pan'ning-el'e-vat'or.** (*Surgical.*) *e*, Fig. 6647. Also known as a lenticular knife. A lever for raising the portion of bone detached by the trephine.

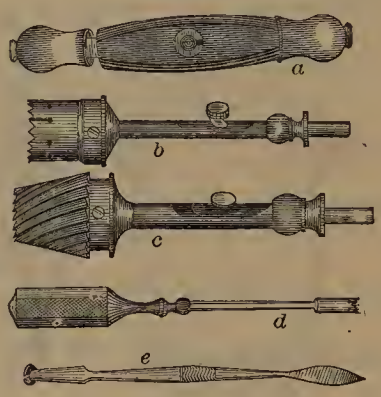
**Tre-phine'.** (*Surgical.*) An instrument for taking a circular piece out of the cranium. It is a cylindrical saw, with a cross-handle like a gimlet and a center-pin (called the *perforator*), around which it revolves until the saw has cut a kerf sufficient to hold it. The center-pin may then be retired.

*a b*, Mott's socket-handled trephine and handle.
*c*, Galt's conical trepbine.
*d*, antrum-drill.
*e*, trepanning-elevator.

Fig. 6646.

*Trepang.*

Fig. 6647.




*Trephines.*

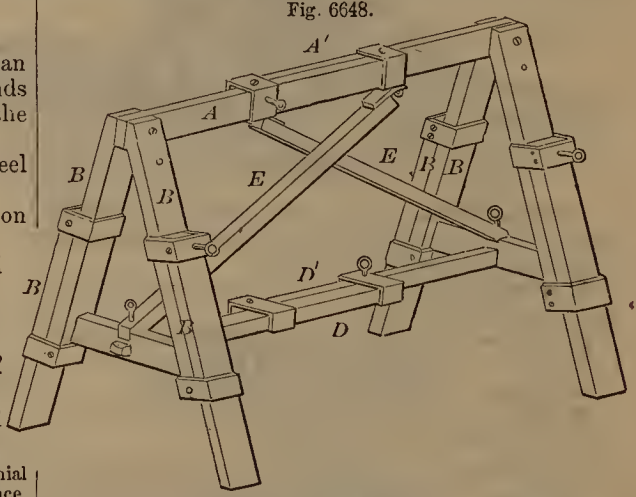
The *trephine* is sometimes worked by a revolving brace like that of the carpenter, and has even been socketed upon a stem with three legs, and turned by one hand while the socket is held by the other.

The *trephine* for the *antrum* (*d*) is a small crown-saw set in the end of a handle. It is used for entering the *antrum* through a tooth-socket.

Trepanning instruments were used by the ancients; Hippocrates (d. 357 B. C.) gives directions for their use, and refers to the operation as widely known. It was in great repute among the Greeks and during the Middle Ages. Fabricius *ab aquapendente* is referred to as an improver of the instrument.

The Kabyles of Africa practice the operation by making four

Fig. 6648.




*Trestle for Scaffolding.*

kerfs in the shape of a square: the eight overlapping extremities of these kerfs show unmistakably the nature of the operation among the native African surgeons; the same marks are

present in some ancient Peruvian skulls presented by Mr. Squier to the Anthropological Society.

The native surgeons of the South-Sea Islanders trepan by laying back a flap of the scalp and scraping away the skull until an inch in diameter of the *dura mater* is exposed. This is supposed to let out the demon of vertigo or neuralgia. Jupiter was cured of a headache by a blow of Vulcan's hammer, and Minerva sprang from the opening. So the Feejee and the Ægean seas meet.

The most wonderful (?) story of skill in surgery connected with cranial contusions is related by Ellis, the traveler in Oceanica and Polyuesia. "It is related, although I confess I scarcely believe it, that on some occasions (in the Society Islands), when the brain has been injured as well as the bone, they have opened the skull, taken out the injured portion of the brain, and, having a pig ready, have killed it, taken out the pig's brains, put them in the man's head, and covered them up." (ELLIS, Vol. II. page 343.) Result not stated.

The article "Cranial Amulets," by Dr. Bertillon, in "La Nature," gives some curious particulars in regard to the practice of trepanning among the people of the Stone Age in Western Europe. He particularly noticed some skulls from the dolmens of Lozere, by Dr. Prunières of Marvejois. The orifices were frequently about the size of a silver dollar, and were evidently made during life, as the edges were cicatrized, and in some cases the substance was entirely restored.

Perforated skulls have also been taken from ancient Peruvian graves and from the Canary Islands.

**Tre-phine'-saw.** A *crown*-saw. A cylindrical saw with a serrated end, to make a circular kerf by the rotation of the saw on its longitudinal axis. See TREPHINE.

**Tres'tle.** 1. A beam or bar supported by divergent legs. It is commonly used by carpenters to support a board while being sawed, or work while being put together, as a door. A *horse*.

The relation of the horizontal piece and oblique supports has caused various kinds of structures to be named from it.

*Trestle-work* of bridges consists of vertical posts, horizontal stringers, oblique braces, and cross-beams.

*Trestle-trees* of a ship's mast are horizontal timbers which support the *tops*.

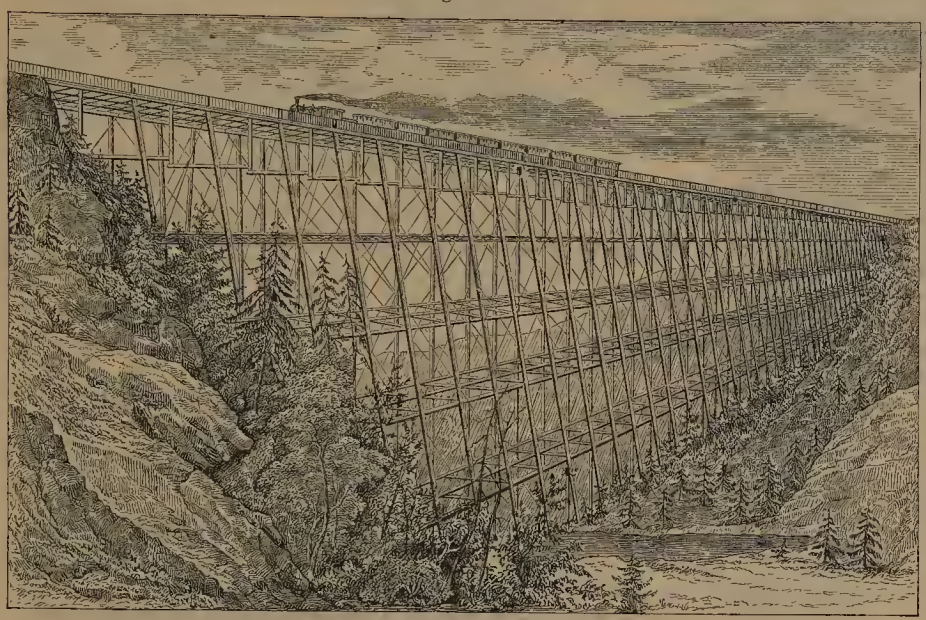
In the trestle and scaffold-supporter (Fig. 6648), the legs *B B*, connecting-bars *A A' D D'*, and braces *E E*, are each in two parts, sliding past each other in collars, and fixed in any position by set-screws, rendering the devices adjustable as to length and hight.

2. The frame of a table.

3. (*Engineering.*) A road-bed or stringer supported by posts or pillars and framing in the intervals. See TRUSS; LATTICE.

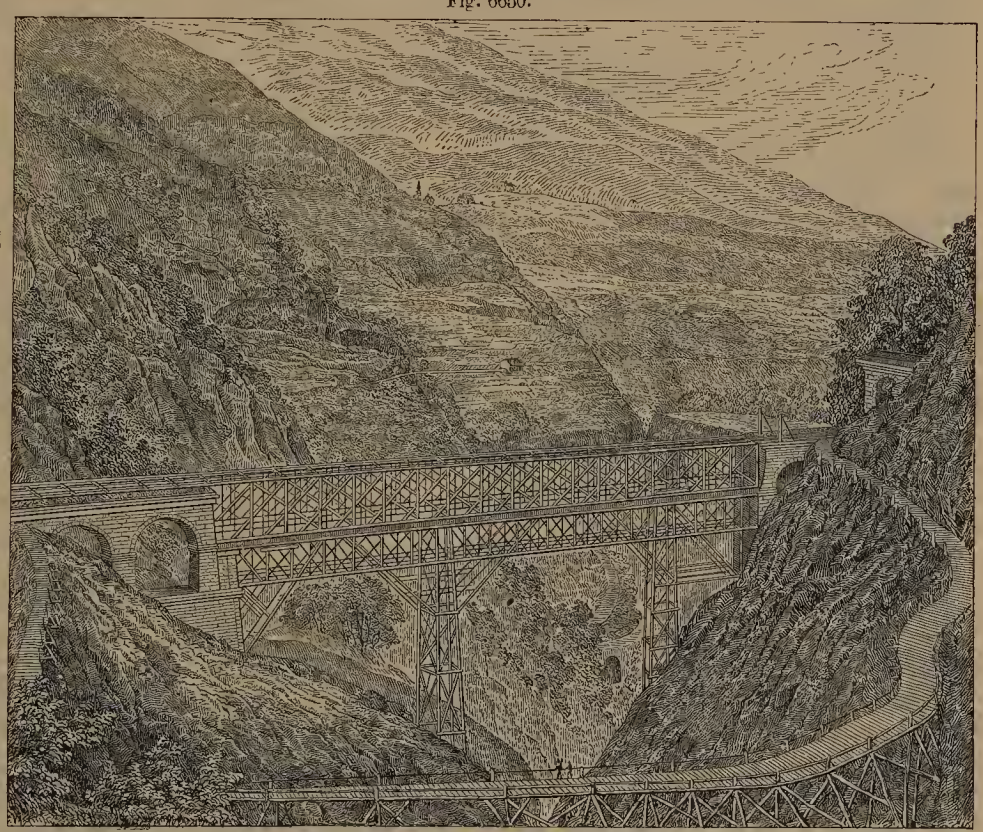
Fig. 6649 is the Lyman Viaduct on the Pacific Railway.

Fig. 6649.



*Lyman Viaduct, Pacific Railway.*

Fig. 6650.



*Comba Scura Bridge, Mt. Cenis Railway.*

Fig. 6650 shows the Comba Scura Bridge, on the Mt. Cenis Railway, spanning a picturesque ravine in a spur of the Piedmontese Alps. It crosses at a hight of 395 feet above the bottom of the valley, and has a span between the abutments of 185 feet 2 inches.

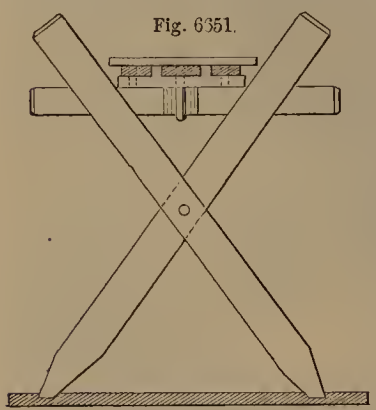
4. (*Leather.*) The sloping plank on which skins are laid while being curried.

5. (*Founding.*) In making loam cores on perforated barrels, the latter are made to revolve slowly by hand in V's of various sizes cut in the upper edge of a pair of iron trestles. From trestle to trestle the loam-board lies, the whole arrangement constituting a crude sort of lathe, but one sufficiently good for the purpose.

**Tres'tle-board.** The architect's designing-board. Formerly supported on trestles.

**Tres'tle-bridge.** (*Engineering.*) One in which the bed is supported upon framed sections which rest on the soil or river-bed. A military expedient, or one used in constructing works of a temporary character. The one shown in Fig. 6651 is understood to have been used in making roads over the Southern marshes and rivers; notably where the "swamp-angel" off Charleston poured her notes. See TRESTLE.

Fig. 6651.



*Trestle for Bridges.*

**Tres'tle-tree.** (*Nautical.*) (*Pl.*) Horizontal fore-and-aft timbers, resting on the *hounds* and secured to a lower mast or topmast on each side below the head. They serve to support the *cross-trees* and the *top*, if any.

**Tres'tle-work.** A viaduct or scaffold supported on piers, and with braces and cross-beams.

**Tre'vat.** A weaver's knife for cutting the loops of velvet pile.

**Trev'et.** A three-legged stool; a *trivet*.

**Tri'al-bit.** (*Saddlery.*) A skeleton-bit used to determine the exact width of the horse's mouth, also the breadth as well as the hight of the *port*.

**Tri'al-jar.** A tall glass vessel used for containing liquids to be tested by the hydrometer. The

Fig. 6652.

*Trial-Jars.*

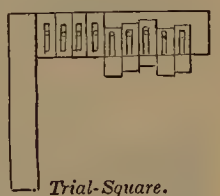
mouth is preferably enlarged, to prevent capillary adhesion of the hydrometer.

**Tri'al-square.** A *test*-square; a *try*-square.

Fig. 6653 is a square for testing an edge which is not straight, having a set of slides which may be considered ordinates. One arm of the square has two parallel blades inclosing slotted pieces, which have a motion within certain limits transversely to the said arm, and which rest against the work and indicate its outline along the upper edge of the square.

**Tri'an-gle.** 1. (*Music.*) An equilateral bar of steel suspended by one angle and having an opening at one of the lower angles, so that the legs are of unequal length. It is struck with a small rod, and is sometimes introduced in brilliant musical passages.

Fig. 6653.



*Trial-Square.*

Possibly the *shalisbim* of the Hebrew Scriptures.

The *triangulum* of the Romans. They had several forms of metallic instruments of percussion; the *cymbalum* plates, used in pairs; *kymbala* of the Greeks; the *crotala* and *crusmata*, kinds of castanets; *krotala* of the Greeks; the *sistrum*, which had jingling rods; the *tintinnabula*, or bells in a frame; the *crepitaculum*, a hoop with rings. See list of PERCUSSION-INSTRUMENTS on page 1501, and under each head there noted.

Fig. 6654.

*Triangles.*

2. (*Drafting.*) A three-cornered straight-edge, used in conjunction with the T-square for drawing parallel, perpendicular, or diagonal lines. It has one right angle, the two others being each of 45° (*b*), or one of 30° and the other of 60° (*a*).

3. (*Building, etc.*) A gin formed by three spars. A staging of three spars.

4. (*Pottery.*) A small piece of pottery, placed between pieces of biscuit ware in the *seggar*, to prevent the adherence of the pieces when fired.

5. A frame of three halberds to which a person is (was) lashed to undergo military punishment.

**Tri-an'gu-lar Com'pass-es.** A compass having three legs, two opening in the usual manner, and the third turning round an extension of the central pin of the other two, besides having a motion on its own central joint.

Fig. 6655.

*Triangular Compasses.*

By this instrument three points may be taken off at once, and it is very useful in constructing maps and charts.

**Tri-an'gu-lar File.** The ordinary, tapering hand-saw file of triangular cross section. Also known as a *three-square* file.

**Tri-an'gu-lar Lev'el.** A light frame in the shape of the letter A, and having a plumb line which determines verticality.

It is used in leveling for drains. One leg being placed on a peg driven flush with the surface of the soil, the other leg is brought round till it touches the surface in another place; here another peg is driven. The inclination, say half an inch in the span of the frame, being determined, a peg is driven at the second station, half an inch below the level at that point. This gives another point of departure, and the process is a repetition of the former procedure.

Fig. 6656.

*Triangular Level.*

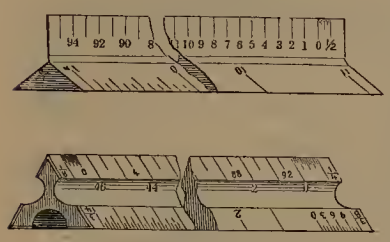
**Tri-an'gu-lar Scale.** Used by draftsmen and engineers for laying down measurements on paper. Each edge is differently divided, giving a variety of scales to select from. The rule being laid flat on the paper, the distances required to be laid down can at once be pricked off, dispensing with the use of dividers.

They are commonly made of boxwood, but sometimes of metal silver, or nickel plated, or of steel.

**Tri-at'ic Stay.** (*Nautical.*) A rope connected at its ends to the heads of the fore and main mast, and having a thimble spliced to its bight for the attachment of the stay-tackle, by which boats, heavy freight, and *spars* are hoisted aboard.

**Trib'ble.** (*Paper-making.*) A large horizontal

Fig. 6657.

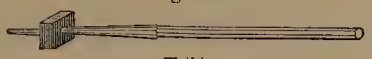


*Triangular Scales.*

frame in the loft or drying-room of a paper-mill, having hairs or wires stretched across it for the suspension of sheets of paper while drying.

**Trib'let.** 1. (*Forging.*) A mandrel used in forging tubes, nuts, and rings, and for other purposes. The nut having been cut from the bar, the hole is punched and enlarged by the triblet, which also serves as a handle while the nut is being finished on the anvil. In the case of a ring, the parts having been joined, the ring is fashioned and shaped on the *triblet* (*tribolet*, Fr.).

Fig. 6658.



*Triblet.*

2. The mandrel in a machine for making lead-pipe.

**Trib'o-let.** See TRIBLET.

**Tri-bom'e-ter.** An apparatus resembling a sled, used in estimating the friction of rubbing surfaces.

**Trib'ute.** (*Mining.*) *a.* Work performed in the excavation of ore in a mine; as distinguished from *tut-work*, which is upon the non-metalliferous rock, as in sinking shafts and the driving of adits and drifts.

*b.* The proportion of ore which the tributer or workman receives for his labor.

**Trib'ute-pitch.** (*Mining.*) The limited portion of a lode which is set to a "pair" of tributers, beyond which they are not for the time being permitted to work.

**Tri'cing-line.** (*Nautical.*) One for raising an object out of the way for head-room, or to stow it.

**Tri'dent.** 1. A three-pronged spear formerly used by the *retiarius* in the gladiatorial contests.

2. A three-pronged fish-spear.

**Trig.** A shoe for a wheel to ride on, in descending a hill. A form of brake.

**Trig'ger.** 1. (*Fire-arms.*) A catch which, being retracted, liberates the hammer of a gun-lock. See illustrations, Plates XVII., XVIII.

A *hair-trigger* is a duplication of parts; the supplementary trigger is released with very slight force, and liberates a spring which instantly retracts the main trigger from the *sear* of the hammer.

2. (*Shipbuilding.*) A piece of wood placed under a dog-shore to hold it up until the time for launching. The dog-shore buts against cleats on the bilgeways, and is knocked away when the signal is given for launching.

3. (*Vehicle.*) A catch to hold the wheel of a carriage in descending a hill.

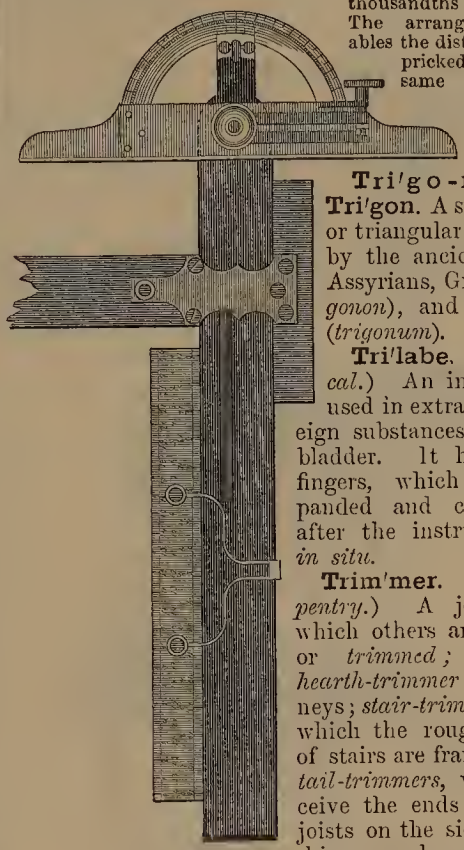
**Trig'ger-line.** The line by which the gun-lock of ordnance is operated.

**Tri'glyphs.** (*Architecture.*) Ornaments repeated at equal intervals in the Doric frieze. Each triglyph consists of two entire gutters or channels cut to a right angle, called *glyphs*, and separated by their interstices, called *fermona*, from each other as well as from two other half-channels that are formed at the sides.

**Tri'gon.** A triangular lyre. See TRIGONON.

**Trig'o-nom'e-ter.** An instrument for plotting angles and laying down distances upon paper, and for solving problems in plane trigonometry by inspection. It has a semicircular protractor with a long arm carrying a T-square and graduated sliding-scale. The protractor may be read to minutes of arc and the scale to thousandths of an inch. The arrangement enables the distance to be pricked off at the same time the angle is set off.

Fig. 6659.



*Trigonometer.*

**Tri'go-non**, or **Tri'gon.** A small harp or triangular lyre used by the ancients; the Assyrians, Greeks (*trigonon*), and Romans (*trigonum*).

**Tri'labe.** (*Surgical.*) An instrument used in extracting foreign substances from the bladder. It has three fingers, which are expanded and contracted after the instrument is *in situ*.

**Trim'mer.** 1. (*Carpentry.*) A joist into which others are framed or *trimmed;* as the *hearth-trimmer* of chimneys; *stair-trimmers*, into which the rough-strings of stairs are framed; the *tail-trimmers*, which receive the ends of floor-joists on the side of the chimney, when they cannot be inserted into the wall on account of flues.

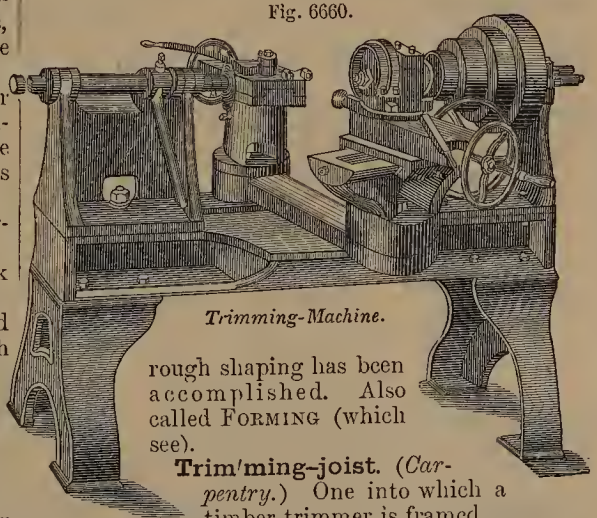
2. (*Bricklaying.*) *Brick-trimmer;* a flat brick arch, turned from the face of the chimney to the timber-trimmer to support the slab. See CHIMNEY.

3. A tool to pare or trim; as, —

Lamp-wick trimmer, Hog's-nose trimmer,
Welt-trimmer, Sheep's-foot trimmer, etc.
Hedge-trimmer,

**Trim'ming.** (*Shipbuilding.*) The final shaping of ship-timbers, etc., after the *conversion* or rough shaping has been accomplished. Also called FORMING (which see).

Fig. 6660.



*Trimming-Machine.*

**Trim'ming-joist.** (*Carpentry.*) One into which a timber-trimmer is framed.

**Trim'ming-ma-chine'.** 1. (*Metal-working.*) A species of lathe for trimming the edges of stamped hollow-ware, such as sheet-metal pans. The article

is chucked on the rotating-head ; and while one portion of the edge is turned off smooth by a cutter, a part already trimmed is turned over, forming a bead around the wire, by which the rim of the pan is stiffened.

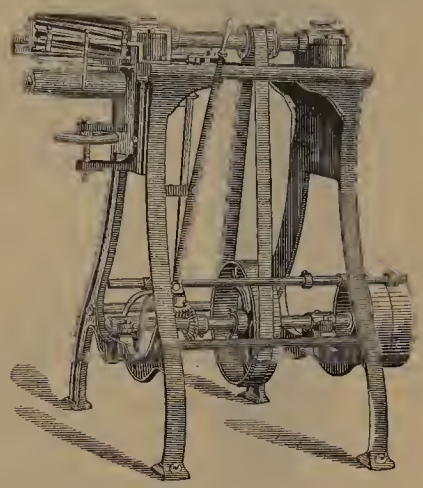
2. (*Boot-making.*) A machine for trimming the edge of uppers.

**Trim'mings.** A general name for ornaments and fittings ; such, for instance, as those used on a harness, the hardware and similar fittings of houses, etc.

**Trim'ming-shear.** A machine for trimming wool borders on Coir, Sisal, and other mats.

It has various adjustments: for width of border not exceeding ten inches, either straight or irregular; and for thickness of material.

Fig. 6661.



*Curtis and Marble's Trimming-Shear.*

**Trin'gle.** 1. A curtain-rod of a bedstead.

2. (*Architecture.*) A little member over the Doric triglyph.

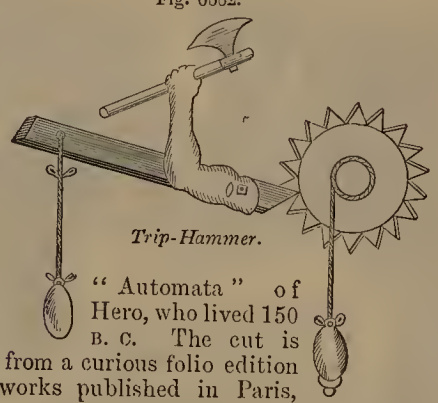
**Trin'glette.** A pointed stick used in opening the cames of fretwork and diamond-paned windows.

**Trin'ket.** (*Nautical.*) The royal or topgallant sail. The upper sail in a ship.

**Trip-ham'mer.** A hammer tripped on its axis by the contact of cam, wiper, or tooth with the tail of the helve.

The annexed cut is perhaps the earliest illustration of the trip-hammer movement. It is from the

Fig. 6662.



*Trip-Hammer.*

"Automata" of Hero, who lived 150 B. C. The cut is reduced from a curious folio edition of his works published in Paris, 1693 ; a copy is in the Patent Office library.

The old French form, the *marteau frontal*, was lifted by projecting arms fixed in a cam ring and falling through a certain space by its own gravity. The *tilt*-hammer which succeeded it, instead of being raised at the front, had its tail depressed by a cam in the rear. Various modifications were known, as the *tennant-helve* and the *belly-helve*, but the *steam*-hammer and various forms of *drop* and *dead-stroke* are rapidly superseding the pivoted helve. See list under HAMMER ; see also TILT-HAMMER.

The Cubberly trip-hammer, shown at the Chicago Exposition, 1875, is said to run 200 strokes per minute, giving blows of any degree of intensity.

**Trip'le-cyl'in-der En'gine.** A steam-engine employing three cylinders.

In one form it has three cylinders arranged at angles of 120°, so as to act coincidently upon a three-throw crank. In the Thames River engines, one of these cylinders is an air-pump cylinder.

In Alden's (patented, May, 1875), two small cylinders alternately receive steam at each revolution, and alternately exhaust into an auxiliary large cylinder, while their pistons are balanced by the exhaust steam. See also THREE-CYLINDER ENGINE.

**Trip'le-in'grain Car'pet.** A carpet made of wool or worsted, dyed in the grain (before manufacture), and consisting of three webs interchangeably united, so that either of the three warps may be brought to the surface to give the color required by the pattern. Each web is woven at the same time, and the warps are governed by the Jacquard arrangement. A *three-ply carpet.*

**Trip'le-shov'el Plow.** A cultivator-plow with three shovels.

**Trip'let.** (*Optics.*) An arrangement of lenses in a microscope, invented by Holland.

In Wollaston's doublet two plane concave lenses were used, but in Holland's two lenses are substituted for the first in the *doublet*, and the *stop* is placed between them and the third lens. The object is the correction of spherical aberration and chromatic dispersion. See LENS.

**Tri'pod.** A three-legged support for a table, chair, surveyor's compass, candelabra, brazier, or other object.

**Tri'pod-jack.** A screw-jack supported on three legs, connected to a common base-plate to give them a sufficient bearing.

Fig. 6663.

*Tripod-Jack.*

**Trip'o-li.** 1. A siliceous polishing-material first imported from Tripoli, Africa.

The *tripoli* of Bilin in Bohemia has been ascertained by Professor Ehrenberg of Berlin to consist of the siliceous plates or frustules of animalculæ and diatomaceæ. They are divested of everything but silex, are hard but fragile, and are of different species. Of one kind there are 41,000,000,000 in a cubic inch, weighing 220 grains ; 187,000,000 to a single grain.

Infusorial earth has been employed in the manufacture of fire-brick and for the lining of furnaces ; its adaptation for this purpose is owing to the fact that it contains but a very small proportion of material capable of acting as a flux, being composed of nearly pure silica.

Floating bricks were made by the ancients, according to Posidonius, from a kind of argillaceous earth, which was employed for cleaning silver-plate. As tripoli is too heavy to float in water, M. Fabbroni experimented with a number of mineral substances, which it seemed might be adapted for making brick of this kind, and at last succeeded in producing them by using fossil meal, a kind of earth abundant in Tuscany, containing, according to M. Fabbroni, 55 parts of siliceous earth, 15 magnesia, 14 water, 12 alumina, 3 lime, and 1 iron.

It is infusible in the fire, loses about $\frac{1}{8}$ of its weight in baking, and but little of its volume.

Bricks made of this substance float in water, either burned or unburned, and $\frac{1}{20}$ of clay may be added without destroying this property. They resist water, unite readily with lime, and are nearly as strong as common bricks, with but about $\frac{1}{6}$ of their weight. They are such bad conductors of heat that one end may be made red-hot while the other is held in the hand, and are well adapted for furnaces and where great heat is to be sustained, as well as in constructions where extreme lightness is desirable, as for domes, etc.

2. Rotten-stone. A light-brown siliceous earth used as a polishing-material. Sometimes made from *clunch* or *septaria*. One analysis gives : —

| | |
|---|---|
| Silica | 81 |
| Alumina | 1.5 |
| Iron | 8 |
| Sulphuric acid | 3 45 |
| Water | 4.55 |
| | 98.55 |

It is now found in numerous localities. It is prepared by calcining and grinding, and has various colors.

**Trip'pet.** (*Machinery.*) A projection intended to strike some object at regularly recurrent intervals. A *cam*, *lifter*, *toe*, *wiper*, *foot*, etc.

**Trip'ping-line.** (*Nautical.*) A rope used in lifting a spar while disengaging it from its usual attachments, previous to sending it down.

**Trip'ping-valve.** One moved recurrently by the contact of some other part of the machinery.

In Cartwright's steam-engine (Fig. 5664), the valves were moved by the contact of the stems with the cylinder foot, the piston, etc. One valve was in the piston, and was tripped by the contact of the valve-stem with the bottom of the cylinder. Another poppet-valve was at the head of the cylinder, and controlled the eduction. It was tripped in one direction by the contact of the piston, and in the other by the descent of the cross-arm on the piston-rod.

**Trip-shaft.** (*Steam-engine.*) A supplementary rock-shaft, used in starting an engine.

**Tri-spas'ton.** A tackle with three blocks.

**Trit-u-ra'tion.** Reducing to a fine powder or magna by grinding or stamping. The action may be in a mill, a mortar, or arrastra, or on a slab by a muller. The latter is specifically *porphyrization*.

Trituration is generally conducted dry; *levigation* is comminution assisted by a liquid.

Trituration of grain is usually conducted between stones, as in GRINDING-MILLS (which see).

Of spices and allied articles, such as coffee, pepper, etc., by *steel mills*. See COFFEE-MILL; PAINT-MILL; etc.

Of drugs and snuff, by *pestle and mortar*. See MORTAR.

Of ores and rocks, by edge-rollers (see CHILIAN MILL), stamps, or by horizontally rotating mullers in pans. See AMALGAMATOR; ARRASTRA. See also Plates XXXIV., XXXV., and pages 1567 - 72.

The variety of mills or grinders is very great, and a list may be found under MILL (page 1440).

**Triv'et.** 1. The knife wherewith the loops of *terry* fabrics are cut. Velvets and Wilton carpets, for instance, are woven with loops, the warp being carried over wires in the shed.

On the top of each wire is a groove which forms a guide for the *trivet*, which, by a dexterous motion of the operator, is thus driven along the wire, cutting all the loops and making a *pile* fabric; or *cut-pile* fabric, as it is more specifically called.

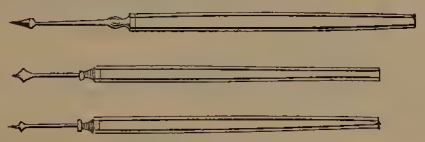
2. A *tripod*. A three-legged arrangement for supporting an object, as a pot or kettle; this may be effected by slinging it from a hook suspended from the point of junction of the three legs, or the legs may be set 120° apart, straddling outward from and supporting a ring sufficiently large to receive the bottom of the pot.

**Tro'car.** (*Surgical.*) (Fr. *Troiscarré*, three-faced.) An instrument consisting of a perforator or stylet and a cannula. After the puncture is made the stylet is withdrawn, and the cannula remains and affords a means of evacuating from the cavity. Used in case of dropsy, hydrocele, etc.

Tapping for the dropsy was practiced by the ancients.

Fig. 6664 shows forms of trocars for puncturing the eye in cases of dropsy of that organ.

Fig. 6664.

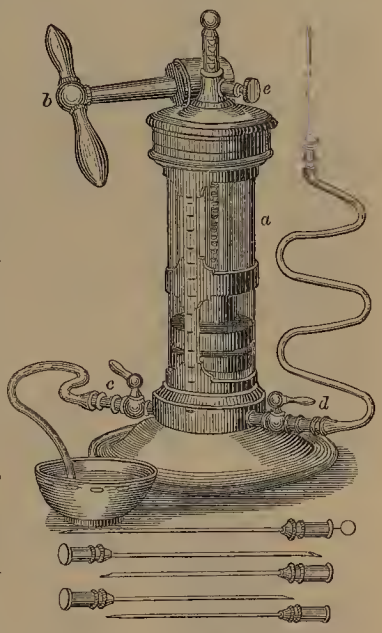


*Paracentesis Trocars.*

The instrument (Fig. 6665) invented by Dr. Dieulafoy of Paris is designed to remove fluids from cavities by means of capillary tubes and a suction-pump, so as not to leave an open wound nor admit air to the cavity.

It consists of a glass cylinder *a* about 7 inches in hight and 2 in diameter, partly covered with a silver-plated casing, and having a tightly fitting piston which is raised or lowered by turning the handle *b*. Near the bottom of the cylinder are the induction and eduction openings *d c*, fitted with rubber tubes. The capillary tubes or trocars are six in number, and of different sizes; one is shown attached to the induction-tube *d*, and five below the instrument. In addition to these there should be two or three small blunt cannulas with trocars and a detachable handle, so that when the trocar is withdrawn the cannula may be attached to the instrument. In using the instrument, the cocks *c d* are closed and the handle *b* turned, producing a nearly perfect vacuum in the cylinder; the piston is held in raised position by a spring *e*. The trocar is introduced with a rotary motion into the part from which the fluid is to be withdrawn; on opening the cock *d* it flows into the cylinder, which is emptied when full by closing *d*, opening *c*, pulling out the spring *e*, and lowering the piston; when this is done, both cocks are again closed, and the operation repeated.

Fig. 6665.




*Dieulafoy's Aspirator, with Trocars.*

The cylinder is provided with a scale graduated to grammes, for showing the amount of contained fluid, and a glass tube is inserted near the outer end of the induction-tube, through which the fluid while passing may be inspected.

The instrument is useful for removing fluids from the pleural and cranial cavities and the knee-joint; for withdrawing pus from abscesses; gas and the fluid contents of the intestines; and it has been employed for puncturing the bladder above the pubes in cases of retention of urine. Local anæsthetics may be applied to the part under treatment.

**Tro-chei'do-scope.** An instrument designed for displaying the effect of the combination of colors.

It consists of a whirling table operated by a crank, and painted of different colors, having a spindle arising from its center, by which are suspended disks having the outlines of various patterns cut out of them. The patterns are, one at a time, attached to this disk and to a branch projecting from the side of the table, which is rotated with sufficient rapidity to cause them to appear blended, though each is distinctly visible in the pattern disk, owing to its receiving a constant vibratory motion from the table. Were this not the case, the distinction of colors would not be visible. — *Mech. Mag.*, N. S. Vol. III. p. 268.

**Tro-chom'e-ter.** An *odometer*. A *trochometer*.

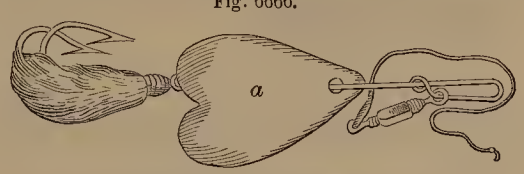
**Trogue.** (*Mining.*) A wooden trough forming a drain.

**Trol'ley.** A vehicle on the ways or tracks of iron works.

**Troll'ing-spoon.** A bait trailed behind a boat to attract and catch fish.

The name is derived from the frequent use of a silvered spoon bowl to which the hook is soldered, and which is connected by a snood to the line. In the example, the bright piece *a* is rotated as it is drawn through the water, and reflects the light in different directions, like the silvery scales of a small fish in motion.

Fig. 6666.




*Mann's Trolling-Spoon.*

**Troll-plate.** (*Machinery.*) A rotating disk employed to effect the simultaneous convergence or divergence of a number of objects; such as screw-dies in a stock, or the jaws of a universal chuck.

**Trombe.** See TROMPE.

**Trom-bone'.** 1. (*Music.*) A wind-instrument of metal, whose middle piece slides telescopically upon the *mouth-piece* and *pavilion* ends. Its capacity for modulation of tone by means of its slide gives it command over every tone within its compass, without keys or valves. It is made *en suite*, that is, of varying sizes and compass. See HORN, *h*.

The English *sackbut* of the ninth century could be drawn out to alter the pitch of sound. The French name in the fifteenth century was *sacquebutte* or *sacqueboute*; from *sambuca*.

Trombones are of four kinds, each of which bears the name of the human voice to which it bears the nearest resemblance in quality of tone and compass. The *soprano* is the smallest and highest; it doubles the soprano voices of the chorus, but is but little used. The other trombones are the *alto*, *tenor*, and *bass* trombones, and double those voices.

The *alto trombone* has a compass of more than two octaves and a half, and is also known as the trombone in E♭. It is written on the C clef, third line.

The *tenor trombone* is also known as the trombone in B♭. It is written on the C clef, fourth line.

The *bass trombone* is the lowest of all in its range of notes, and is known as the E♭. It is written on the F clef; is an octave lower than the alto, and a fifth lower than the tenor.

Fig. 6667.

*Tromba Spezzata.*

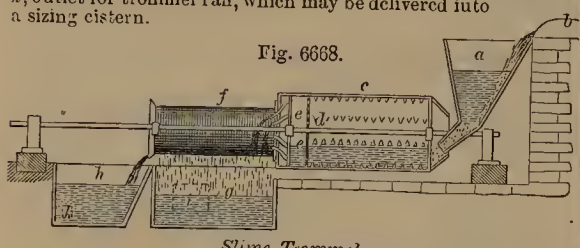
Fig. 6667 is an illustration of a trombone, from the curious work of Père Bonanni, "Description des Instrumens Harmoniques," Rome, 1776. It is there called the *tromba spezzata*, or Trompette Rompüe. It has two tubes, one slipping in the other, to vary the note. It is described as held by the left hand, and the movable section operated by the right; also as the most harmonious and versatile of all instruments. It is described by Père Mersenne in his book on harmonic instruments, called by the French *sacquebule*, and having 15 feet total length of pipe. Scacchi Mirot attributes the invention to the Egyptians, but without sufficient apparent reason.

2. A form of blunderbuss for boat-service.

**Trom'mel.** (*Metallurgy.*) A form of *buddle* or machine for separating the richer portions of slimes from the worthless.

*a*, Fig. 6668, is the hopper in which the slimes are lodged; *b*, *launder*, delivering clean water into the hopper; *c*, *trommel*, having spikes in the interior for the purpose of dividing the stuff; *d*, perforated disk, to prevent the passage of chips or bits of stone; *e*, Archimedean pipes fitted into a disk of sheet-iron to convey water to the gauze or perforated trommel *f*; *g*, slime-cistern; *h*, cistern for receiving the rough stuff; *i*, slime-outlet, communicating with round buddle or other suitable apparatus; *k*, outlet for trommel raff, which may be delivered into a sizing cistern.

Fig. 6668.



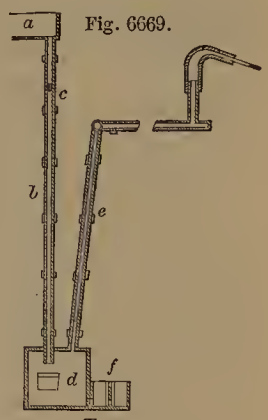

*Slime-Trommel.*

**Trompe.** The water-blowing engine; used as a furnace-blast in Savoy, Carniola, and some parts of America.

Water from a reservoir *a* flows through the pipe *b*, which is contracted just below the reservoir to divide the stream into a shower, and has oblique perforations at *c*, through which air enters and is carried down by the water, which impinges upon a plate in the drum *d*, separating the air which is compressed in the upper part of the drum, flowing through the pipe *e* to the tuyeres or blast-pipes. At the bottom of the drum *d* is an orifice for the escape of water, which flows into the chest *f*, divided into two parts by a slide to prevent the air from issuing with the water. By raising or lowering the slide, the water within the drum may be retained at any required level to give the air a greater or less compression. The cistern has a floodgate to regulate the admission of water. The contracted portion of the tube *b* is termed the *etranguillon*.

See Lewis's "Glossary of Commerce," page 267; see also Carl, "Repositum Phys. et Tech."

Fig. 6669.




*Trompe.*

**Tron.** 1. A steelyard balance.

2. A wooden air-shaft in a mine.

**Tro'phy.** A commemorative or triumphal erection.

The trophies of the Greeks were decked out with the arms of the vanquished for land victories; with the shatters of the enemy's vessels, for naval engagements. It was deemed sacrilege to demolish them, as they were consecrated to some deity; and a crime to repair them, as it prolonged quarrels. The erection of stone pillars was deprecated, as making animosities eternal.

**Trouble.** (*Mining.*) A difficulty in a coal-mine, arising from the interposition of a layer of sandstone dividing the seam into two portions; a *fault*, or the gradual closing in of the strata above and below, terminating the seam. The latter is called a *nip*.

**Trough.** 1. (*Electricity.*) *a*. The tray or vat containing the metallic solution used in electroplating.

*b*. The array of connected cells in which the copper and zinc plates of each pair are on opposite sides of the partition. See GALVANIC BATTERY.

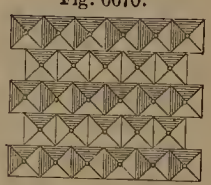
2. (*Chemistry.*) The vat or pan containing water over which gas is distilled. See PNEUMATIC TROUGH, Fig. 3855, page 1755.

3. (*Metallurgy.*) A *frame*, *vat*, *buddle*, or *rocker* in which ores or slimes are washed and sorted in water. See list under METALLURGY.

**Trough-bat'ter-y.** A compound voltaic battery consisting of a number of cells in a trough; the plates being united by a bar of wood and electrically connected by wires, the copper of each pair to the zinc of the next pair. See GALVANIC BATTERY.

**Trous-de-loup.** (*Fortification.*) Rows of pits in the shape of inverted cones with a pointed stake in each; intended as a defense against cavalry.

Fig. 6670.



*Trous-de-Loup.*

**Trow.** A boat with an open well between the bow and stern portions; used in spearing fish.

**Trow'el.** 1. A tool *e*, like a small scoop, used by gardeners in potting plants, etc.

2. A mason's and plasterer's flat triangular tool *d* for spreading mortar.

The *trua* (diminutive *trulla*) of the Romans was a tool with a handle and flat blade, used in plastering. The same name was applied to a perforated ladle or skimmer.

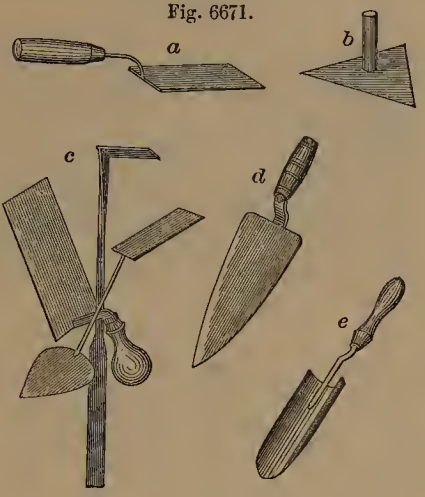
3. (*Founding.*) A tool for smoothing the loam in molding.

They are of different shapes and sizes, as *a b c*. They are employed in the foundry for restoring broken corners or parts which become ruptured when drawing a mold away from the pattern after ramming; and for smoothing the surface of the sand or loam composing the mold.

Fig. 6672 illustrates trowels and kindred tools used by molders in forming the molds of loam or sand employed in casting metals.

*a*, square trowel.
*b*, heart-trowel.
*c*, dog-tail.
*d*, heart and square.
*e*, lifter.
*f*, flange-lifter.

Fig. 6671.

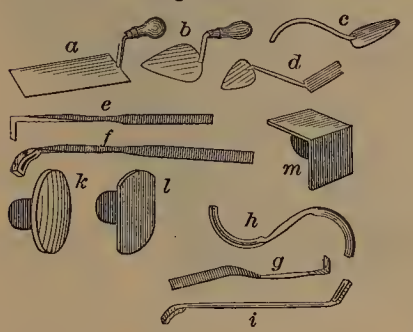



*Trowels.*

*g*, "Yankee" slick.
*h*, bead-slick.
*i*, circular and flat flange.
*k*, button-slick.
*l*, pipe-slick.
*m*, square corner.

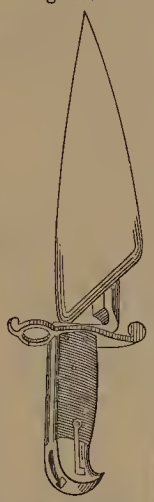
**Trow'el-bay'o-net.** A bayonet resembling a mason's trowel, used as a weapon, and as a light intrenching-tool, or as a hatchet when detached from the rifle. Invented by Lieutenant-Colonel E. Rice, U. S. A.

Fig. 6672.




*Molders' Trowels, etc.*

Fig. 6673.



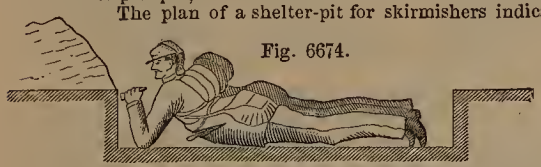
*Trowel-Bayonet, with Handle.*

The bayonet shown in the cut is fastened to the rifle by a spring clamp. It weighs about 15 ounces. As an intrenching-tool it has been found very useful in light soils, and 10,000 bayonets of this pattern are now making at the Springfield Armory, to be placed in the hands of troops in the field.

Fig. 6674 shows a section of trench capable of sheltering two ranks. It has a width of 7 feet; depth, 1 foot 3 inches; hight of parapet, 1 foot 6 inches.

The plan of a shelter-pit for skirmishers indicates the dimensions; depth of excavation, 6 inches; hight of parapet, 1 foot 2 inches.

Fig. 6674.



*Shelter-Pit.*

The depth of the ditch and hight of the parapet will vary according to the form of the ground at the spot; the object being to completely protect the soldier while lying down, from a direct fire.

**Trow'eled.** The finishing-coat of plaster in the best three-coat work. It is smoothed with the trowel, and forms *stucco*. The action of traveling has an important specific effect in the quality of the work.

**Trow'sers.** A bifurcated garment for the legs and lower portion of the body.

They were called *braccæ* by the Romans, and regarded by them as barbarous (*tegmen barbarum*). They were not worn by the Greeks or republican Romans, but were afterward used by the emperors. They were the native dress of the Medes, Persians, Phrygians, Sarmatians, Dacians, Belgians, Britons, and Gauls. The Latin word *braccæ* still survives in the English *breeches* and Scottish *breeks*.

The European *braccæ* were of wool, linen, and leather; the Asiatic, of silk or cotton.

Strabo says that the Persian attire was derived from the Medes. "A hat, a tunic with sleeves reaching to the waist, and trowsers, are proper to be worn in cold and northerly places, such as Media. The custom of the vanquished appeared so noble to the conquerors that they adopted it.

Breeches were worn by Augustus, who had a habit of taking cold; they reached a little below the knees, and were called reproachfully, *feminalia*. They were worn by the Roman horsemen of the Empire; are shown on the Column of Trajan, the Arch of Constantine, and elsewhere.

**Truck.** 1. (*Nautical.*) *a*. A small wooden disk at the extreme summit of a mast. It may contain the pulleys for the signal halyards.

*b*. A circular perforated block like a wooden thimble, and acting as a *fair-leader*.

2. A roller at the foot of a derrick or gin by which the position of the hoisting-apparatus may be shifted.

3. (*Ordnance.*) A small solid wheel on which a certain description of gun-carriage is based.

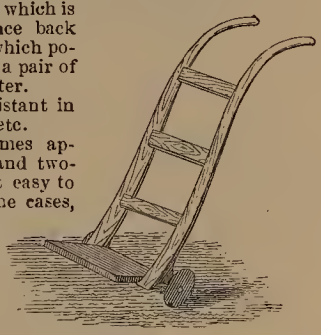
4. A low two-wheeled vehicle for conveying goods and packages.

The hand-truck is an efficient vehicle for removing single packages of considerable weight; the curved bar in front being insinuated under the box, for instance, which is then tipped so as to balance back slightly against the bed, in which position it is transported upon a pair of heavy wheels of small diameter.

It is an indispensable assistant in warehouses, express-offices, etc.

The term *truck* is sometimes applied to certain hand-carts and two-wheeled barrows. It is not easy to make the distinction in some cases, and perhaps not very important. See WHEELBARROW.

Fig. 6675.



*Hand-Truck.*

5. A wagon with a low bed, for moving heavy packages.

Fig. 6676 illustrates what is known as the *crane-neck* truck. The fore part is connected to the body by an arched bar, which permits the fore wheels to turn beneath it.

6. A low platform on wheels for moving buildings, heavy stone block, safes, etc. Fig. 6677.

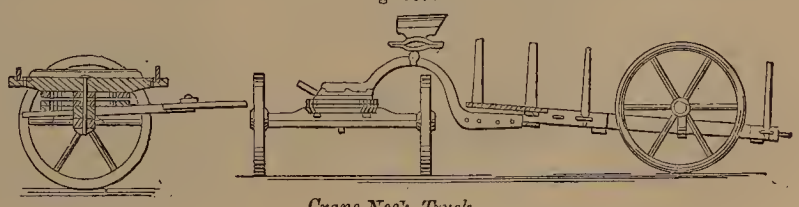
7. (*Railway.*) A swiveling carriage with four or six wheels beneath the forward part of a locomotive, or supporting one end of a railway-car, either passenger or freight.

The long car supported on swiveling trucks is one of the peculiar features of American railway rolling-stock.

Fig. 6678 is a truck for street-cars, and shows a peculiar mode of bracing the pedestals.

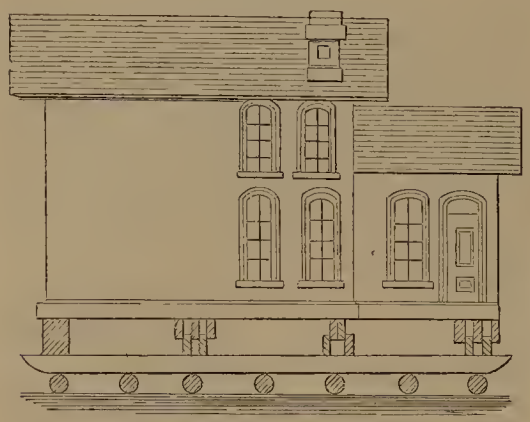
Fig. 6679 is for railways, and shows a system of bracing and transferring the imposition of weights until they eventually

Fig. 6676.



*Crane-Neck Truck*

Fig. 6677.



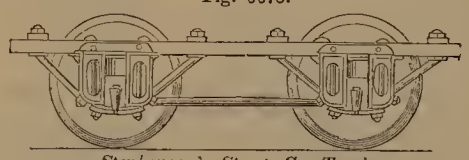
*Truck for Moving Buildings.*

come upon the brasses, which rest on the axles. See CAR-TRUCK, pages 488 - 90.

**Truck-jack.** A lifting-jack suspended from a truck-axle to lift logs or other objects so that they may be loaded on to a sled or other low-bodied vehicle. The calipers that embrace the log are hooked to the catch on the end of the ratchet-bar. The bar is raised by the lever, and is dogged by its attendant pawl.

**Truck'le.** A small wheel. A caster.

Fig. 6678.

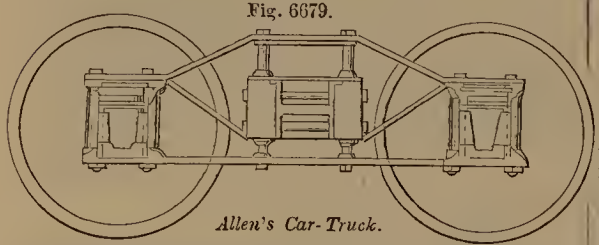


*Stephenson's Street-Car Truck.*

**Truck'le-bed.** One running on casters, out and in beneath an ordinary bed. A TRUNDLE-BED (which see).

The truckle-bed was formerly appropriated to the squire or serving-man. See "Merry Wives of Windsor," Act IV. sc. 5;

Fig. 6679.

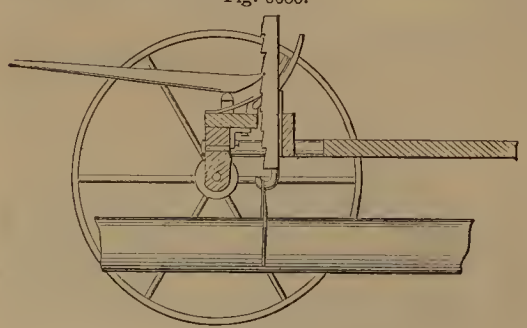


*Allen's Car-Truck.*

where the landlord of the Garter Inn says of Falstaff's room, — "There 's his chamber . . . . his standing-bed, his truckle-bed."

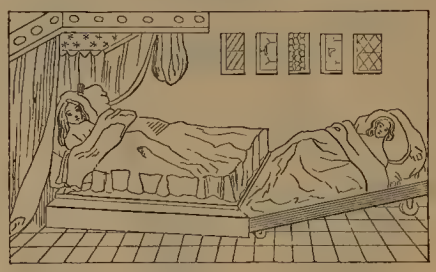
The illustration is from the manuscript of the "Comte d'Artois," and shows the count in one bed, his wife, disguised

Fig. 6680.



*Truck-Jack.*

Fig. 6681.



*Truckle-Bed.*

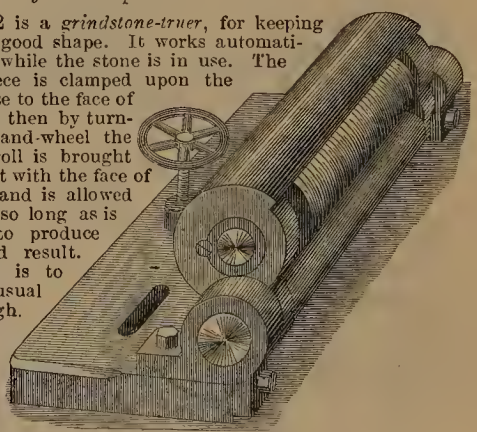
as his valet, in another. See also Hudibras, Part II., Canto II., where Hudibras

"With knocking loud and bawling,
He roused the squire in truckle lolling."

**Trug.** A mortar hod.

**Tru'ing-tool.** A device for truing the face of a grindstone, or any other surface for which it may be adapted.

Fig. 6682.



*Brown and Sharpe's Grindstone Truing-Tool.*

Fig. 6682 is a *grindstone-truer*, for keeping the face in good shape. It works automatically, and while the stone is in use. The bottom piece is clamped upon the trough close to the face of the stone; then by turning the hand-wheel the threaded roll is brought into contact with the face of the stone, and is allowed to remain so long as is requisite to produce the desired result. The water is to be left as usual in the trough. When by long use the thread on the hardened roll becomes worn it is re-cut.

**Trum'pet.** 1. (*Music.*) An instrument of the horn kind, in various keys, some having lengthening pieces by which the key is changed. It is written on the C clef.

Trumpets with pistons and cylinders give all the intervals of the chromatic scale. Valved trumpets have a movable valve similar to that of a trombone.

Wilkinson states that the drum and trumpet frequently occur in the battle-scenes of Thebes. The trumpeters are represented standing still, summoning the troops to form, or in the act of charging with the troops. Fig. 6683.

"The people of Busiris and Lycopolis, in Egypt," says Plutarch, "objected to the trumpet, considering that its sound resembled the braying of an ass and reminded them of the evil genius."

The trumpet was known in Egypt before the siege of Troy. Homer seldom mentions it, but speaks frequently of the flute, lyre, and pipe.

They were in common use among the Israelites, and were employed in the ceremonials at the new moon and other sacred occasions. They are mentioned in the Book of Job. The Israelites probably derived the use of them from their Egyptian associations, as they had but little use for them when they went down into Egypt as a nation of shepherds, 1706 B. C. They appear to have been carried by the officer in command of what we might call a regiment, "the captain of their thousand," as Jesse said to David when he sent ten cheeses to the colonel. Gideon's fifty trumpets signified fifty bodies of troops, — no mean body for a night attack.

By the command of Joshua the priests blew the trumpets at Jericho. (Joshua vi. 8.) Ehud and Gideon marshaled their men by trumpets.

The Hebrews had three kinds of trumpets, *keren*, *shophar*, *chatzozerah*. The first two were more or less curved, and were horns. The last mentioned was a straight trumpet, about two feet in length. It is shown on the Arch of Titus, where a triumphal procession, after the fall of Jerusalem, is depicted. The *salpinx* of the Greeks; the *tuba* of the Romans.

The *keras* was the brass curved horn of the Greeks; the *cornu*, of the Romans.

Fig. 6683.

*Egyptian Trumpeters (Thebes).*

Xenophon mentions, in the "Anabasis," the ceremonies at the Thracian banquets: —

"And after this came men who played on horns, such as are used for giving orders with, and also on trumpets made of raw bull's-hide, in excellent tune, as if they had been playing on a magadis" (a harp with twenty strings, arranged in octaves).

The Greeks had six varieties of trumpets in their armies; the Romans but four. The Greeks had lyres, pipes, flutes, and cymbals for martial music; the Romans, only the trumpet.

The famous lines in the "Æneid," which are considered as onomatopoetic, are, —

"*At tuba — terribi — lem soni — tum procul — ære ca — noro.*"

The equally famous ones which are held to resemble the cadence of a gallop are, —

"*Quadrupe — dante pu — trem soni — tu quatil — ungula — campum.*"

The Roman *tuba* (trumpet) was straight; the *cornu* (horns or shells), curved; the *lituus* had a straight stem, and curved near the bell-mouth. It was shaped much like a tobacco-pipe, but was much larger. It was for cavalry, harsh and shrill in its tones.

The invention of the trumpet is by the Romans uniformly ascribed to the Tyrrheni (Etruscans).

Fig. 6684 is an illustration of a trumpet, from the curious work of Père Bonanni, "Description des Instrumens Harmoniques," Rome, 1776. It is referred to under the name of

Fig. 6684.

*Tromba.*

Fig. 6685.

*Brazilian Trumpet (Native).*

the *Courbée Antique*, or Roman trumpet, and is described as so large that it could only be carried by means of a bar resting upon the shoulder. It is taken from sculptures on ancient tombs.

Lilius Geraldus says that the bodies of mature persons were carried to the grave with the sound of trumpets; those of juniors, with the sound of flutes.

In the museum of Rio Janeiro is preserved the trumpet of one of the aboriginal Caziques. The substance of which it is formed is hard and black, and appeared to be handsomely carved. The divergent orifice is furnished with a double row of red and scarlet feathers, which add to its length, and may, by vibration, affect the tones. It is made of the end of an alligator's tail.

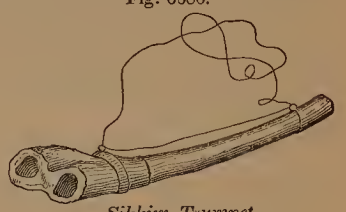
The trumpets of the Araucarians were of wood, and one described by Gumilla was found among the Indians of the Orinoco. A trumpet much venerated by the Indians of a tributary of the Rio Negro is made of strips of palm-wood, the mouthpiece fitted with clay to the smaller end of the tube. Another trumpet of the Amazon Indians is called the *turé*, and is used in war. It is made of a long and thick bamboo, and has a split reed in the mouthpiece like an *oboe*.

The funeral trumpet, or *botuto*, of the Orinoco Indians has a number of enlargements on the tube, is made of baked clay, and is three or four feet long.

The Peruvians also possessed *flutes* of various sizes; the *tinga*, a guitar with five or six strings; the *tambourine*; and the *syrinx*.

The trumpets of the Lamas of Sikkim are made of human thigh-bones; and as the corpses of the lamas of this province are usually burned, the necessary bones are obtained from Thibet, where the bodies of the defunct are cut to pieces and thrown to the kites or into the water. The bone is perforated through both condyles.

Fig. 6686.



*Sikkim Trumpet.*

The trumpet of the Lamas of the Tartarian temples is a conch-shell, blown by turns toward the four cardinal points, — south and north, east and west. The south has the place of honor and precedence in statement in China.

Maelzel's automaton flute-player was exhibited about 1800. It was dressed as a trumpeter of Austrian dragoons, and when wound up by a key, played several marches, gave the trumpet-calls of the Austrian and French cavalry, and several other pieces.

The longest Anglo-Saxon trumpets were placed on a stand when blown. Specimens of the *oliphant* are still preserved.

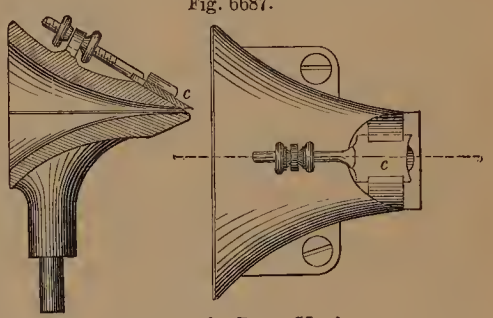
2. (*Music.*) A stop of an organ having reed-pipes tuned in unison with *open diapason*. The *octave-trumpet* or *clarion* stop is an octave higher. See STOP.

3. An ear-tube or conductor of sound. See ACOUSTIC INSTRUMENTS; EAR-TRUMPET.

4. (*Spinning.*) *a.* The funnel which leads a sliver to the cylinders of a *drawing-machine*, or which collects a number of combined rovings, and leads them to condensing cylinders, as in Fig. 1751, page 744, for instance.

Fig. 6687 shows a sectional and a top view of a trumpet for railway draw-heads, which has a throat made adjustable by a

Fig. 6687.




*Trumpet for Draw-Head.*

plate *c*, which is closed or opened by a set-screw, so as to allow a sliver of not exceeding a given thickness to pass.

*b.* A funnel-shaped conductor used in many forms of thread-machines and stop-motions in braiding, knitting, spinning, and doubling machines.

5. (*Railway.*) The flaring mouth of a railway-car draw-head which directs the entering coupling-link.

**Trum'pet-ing.** (*Mining.*) A small channel cut behind the brickwork of the shaft.

**Trun-cat'ed Roof.** One with a nearly level top surface and canted sides. See CURB-ROOF; MANSARD ROOF; etc.

**Trun'dle.** A pair of round disks united by round bars or *rundles* which act as teeth. A form of pinion; also known as a *wallower* or *lantern* wheel. A *trundle-wheel*. See also LANTERN-WHEEL.

**Trun'dle-bed.** A low bed on small wheels *trundled* under another in the daytime, and at night drawn out for a servant or children to sleep on. A TRUCKLE-BED (which see).

"My wife and I on the high bed in our chamber, and Willet [the maid] in the trundle-bed." — PEPYS's *Diary*, 1667.

**Trun'dle-head.** 1. (*Nautical.*) The head of a capstan into whose peripheral sockets the capstan-bars are inserted. The trundle-head is from 3 to 5 feet in diameter, and has a handspike-socket for each foot of its periphery. The length of the bars is nearly three times the diameter of the trundle-head, say from 8 to 14 feet.

2. (*Gearing.*) One of the end disks of a *trundle-wheel*.

**Trun'dle-shot.** (*Projectile.*) A bar of iron, 12 or 18 inches long, sharpened at both ends, and a ball of lead near each end. It upsets during its flight.

**Trun'dle-wheel.** A wheel acting as a pinion, in which the cogs consist of *rounds* or *trundles* fastened in disks which are secured to an axle. A LANTERN-WHEEL (which see).

**Trunk.** 1. A long narrow box; a square tube, usually of boards.

A tube, usually wooden, to convey air, dust, broken matter, grain, etc., as, —

*a.* An *air-trunk* to a mine or tunnel.

*b.* A *dust-trunk* from a cotton-cleaner, smut-machine, or factory floor.

*c.* A *broken-material trunk*, to convey graded coal to a wagon or heap, broken quartz from a mill to the stampers, etc.

*d.* A *grain* or *flour trunk* in an elevator or mill, up which the said articles are conveyed by cups on a traveling-band, a spiral screw, or an air-blast, or down which they pass by gravity.

2. (*Mining.*) *a.* A miner's flume or sluice in which the slimes (finely comminuted ore) suspended in water are settled and collected. See TRUNKING.

*b.* A *flume* for conveying water to a gold-washing or silver works. See FLUME.

*c.* An upcast or downcast air-passage in a mine.

*d.* The box-tube in which attle or rubbish is sent out of the mine.

*e.* A wooden spout for water, or the pipe of the draining-pump.

3. (*Hydraulics.*) A trough made of planks to conduct water from a race to a water-wheel, a stream to a gold-digging, bleachery, factory, tannery, or mill. A *flume* or *penstock*.

4. (*Pneumatics.*) A boxed passage for air to or from a blast apparatus or blowing-engine, in smelting, or ventilation of mines and buildings. An *air-shaft*.

5. (*Hatting.*) The conduit, tube, or guiding-box which confines the air-currents and directs the fur fibers from the picker to the cone, in hat-body forming-machines.

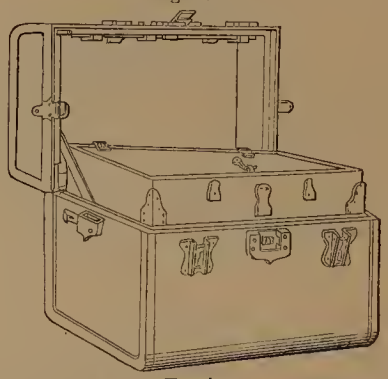
6. (*Railway.*) The main line of a railway.

7. (*Architecture.*) The shaft or body of a column.

8. (*Fishing.*) An iron hoop with a bag to catch crustaceans.

9. (*Steam.*) A tubular piston-rod used to enable the connecting-rod to be jointed directly to the piston or to a very short piston-rod, so as to save room in marine steam-engines. The width of the trunk must be sufficient to give room for the lateral motion of the connecting-rod. See TRUNK STEAM-ENGINE.

Fig. 6688.



*Trunk.*

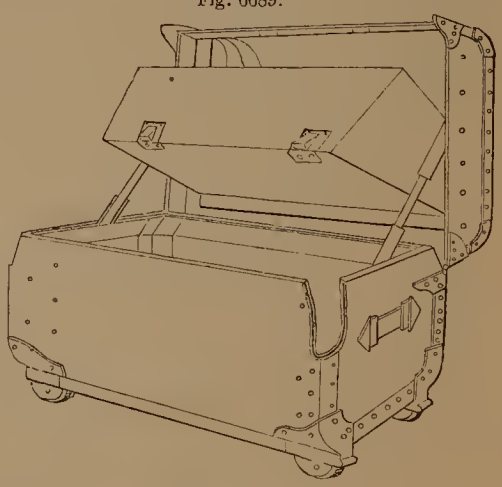
A *double trunk* goes completely through the cylinder, which has a stuffing-box at each end.

10. A chest covered with leather or its substitute, for conveyance of a traveler's clothes and toilet articles.

The trunk-makers of France were incorporated into a company in 1596.

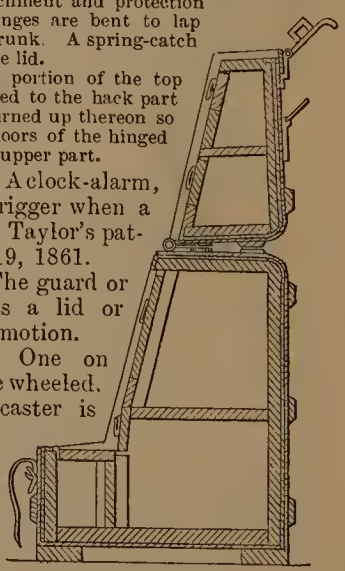
Fig. 6689 shows a trunk with angle-pieces to strengthen the corners; guards to project from the corners of the body when shut. The corner longitudinal strips are bent at right angles at their ends, to lap over the vertical and transverse corner strips. The lower corner guards have projections for attachment and protection of the casters. The hinges are bent to lap around the ends of the trunk. A spring-catch holds the lid-case into the lid.

Fig. 6689.



*Roulstone's Trunk.*

Fig. 6690.



*Burnett's Trunk.*

In Fig. 6690, the front portion of the top part of the trunk is hinged to the back part at the lid, and may be turned up thereon so as to expose the falling doors of the hinged and fixed portions of the upper part.

**Trunk-a-larm'.** A clock-alarm, or one sprung by a trigger when a trunk-lid is opened. Taylor's patent, 31,754, March 19, 1861.

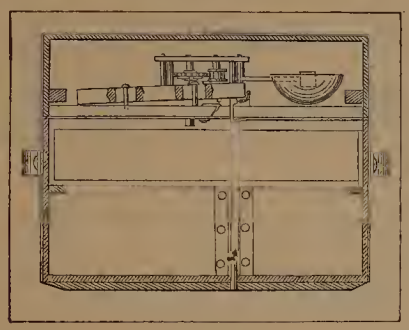
**Trunk-brace.** The guard or stay which supports a lid or checks its backward motion.

**Trunk-cas'ter.** One on which a trunk may be wheeled. In the figure, the caster is journaled in the corner bracket.

**Trunk-en'gine.** See TRUNK STEAM-ENGINE.

**Trunk'ing.** An operation for separat-

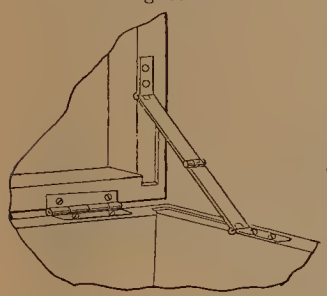
Fig. 6691.



*Trunk-Alarm.*

ing the *slimes* of ores into heavier or metalliferous and lighter or worthless portions.

Fig. 6692.

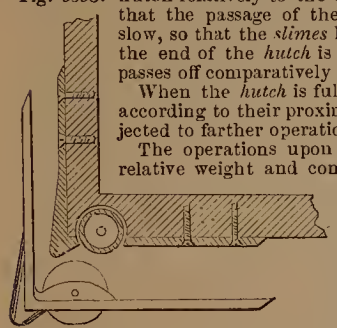


*Trunk-Lid Supporter.*

The *trunk* has three divisions: the *streke*, the *cover*, and the *hutch*.

The *slimes* are placed on the inclined floor of the *streke*, and exposed to the action of a small current of water, say as much as will pass through a ¾-inch pipe with a foot or two of head. The stream carries the slime gradually down into the *cover*, which is a box about 3 feet long and 1 foot wide and deep In the *cover* the slimes are agitated by a shovel, so as to become regularly disseminated in the water, and thence they pass into the *hutch*, which is a wooden box 8 feet long, 3 feet wide, and 1 foot deep.

Fig. 6693.



*Trunk-Caster.*

The skill consists in sending over the water and suspended slimes in a regular manner. The capacity of the hutch relatively to the size of the stream is such that the passage of the water and *slimes* is but slow, so that the *slimes* have time to settle before the end of the *hutch* is reached, where the water passes off comparatively clear

When the *hutch* is full, the contents are sorted according to their proximity to the cover, and subjected to farther operations.

The operations upon ores dependent upon the relative weight and consequent richness of their particles are conducted in a variety of machines, in which water is used as a means of dissemination and suspension.

Some of these machines are fixed, and the ore is agitated by the current, aided by paddles or shovels. Among these are

Buddles,
Trunks,
Tyes,
Keeves, etc.

Other machines which agitate the stamped ores in water are dependent upon the motion of the vessel itself. Such are

Rockers,
Dilluing sieves,
Jiggers,
Frames,
Racks.

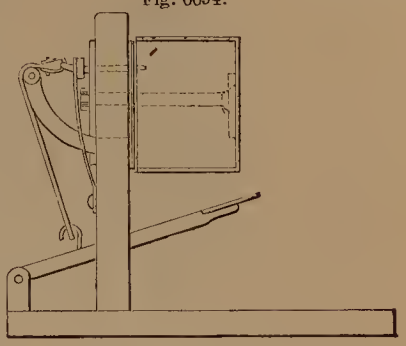
Some of these names are local, and peculiar to a certain ore or mode of treatment. The Cornish ores of tin, copper, and lead are treated with a variety of machines, and the comparative richness of the ore, as well as local customs and prejudices, gives a preference to one or another of the machines, the object being to separate the *ore* from the *gangue;* to concentrate it, in fact, ready for smelting.

**Trunk-light.** A skylight; sometimes at the upper end of an aperture, whose curb or lining is a trunk or square boxing.

**Trunk-lock.** A lock specifically adapted for trunks. It is commonly a snap-lock, which is self-fastening when the lid is shut. There are, however, many forms. See list under LOCK.

**Trunk-mak'er's An'vil.** The trunk is placed upon an anvil-block covered with sheet-iron and mounted on a horizontal pivot on a vertical frame. The rivets are clinched against the sheet-iron plate. Pins working through the frame enter corresponding holes in the block, to hold it at any desired point; the pins are held in operative position by springs, and are withdrawn by a treadle.

Fig. 6694.



*Burnett's Trunkmaker's Anvil.*

**Trunk-nail.** A nail with a head shaped like a segment of a sphere, so as to make a rounded boss when driven. Used for ornamenting coffins and trunks. See NAIL.

Fig. 6695.

*Trunk-Roller.*

**Trunk-roll'er.** A roller journaled in a plate which may be attached to the bottom of a trunk or the like. See TRUNK-CASTER.

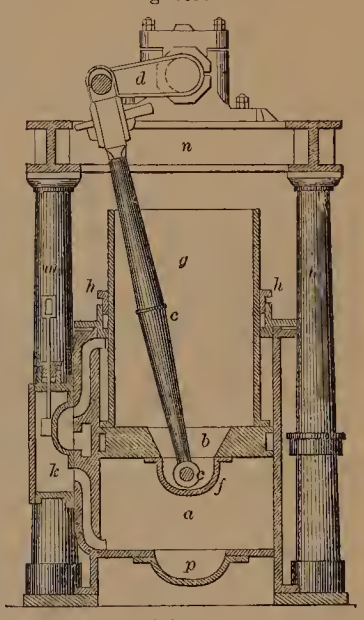
**Trunk-stay.** See TRUNK-BRACE.

**Trunk Steam-en'gine.** The trunk steam-engine was so named by its inventor, Humphrey, 1835. It is designed to obtain the direct connection of the piston-rod with the crank without the intervention of a beam or oscillating the cylinder. Attached to the piston is a tube or *trunk*, which is packed in the cylinder-heads, and has sufficient interior diameter to allow the vibration of the piston-rod by the throw of the crank.

It is used especially for marine and propeller engines.

The *trunk-engine* differs from the annular cylinder steam-engine in the regard that the piston of the latter moves in the space between fixed outer and inner cylinders. See ANNULAR CYLINDER STEAM-ENGINE.

Fig. 6696.



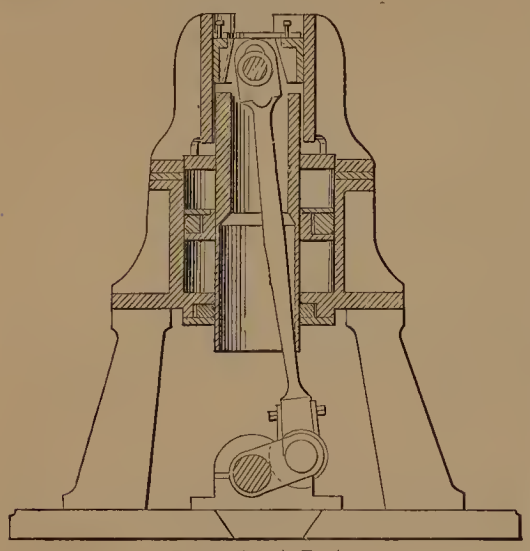

*Trunk-Engine.*

In Humphrey's trunk-engine, *a* is the cylinder; *b*, the piston; *c*, the connecting-rod, the upper end of which is connected to the crank *d*, and the lower end passes through an aperture in the piston, and carries a pin *e*, the ends of which work in bearings attached to the under side of the piston; *f* is a bonnet inclosing the bearings and end of the connecting-rod. The connecting-rod works within a trunk *g*, which is bolted at the bottom to the top of the piston, and which slides in a stuffing-box *h* in the cylinder cover. The sides of the trunk are straight and parallel to each other, and the ends are semicircular; the width is just sufficient to receive the connecting-rod without rubbing, and the distance between the semicircular ends is such as to allow the vibration of the connecting-rod during the revolution of the crank. *k* is the slide-valve, and *m m* the columns supporting the entablature *n*, which carries the plummer-blocks in which the shaft revolves. *p* is a bonnet covering the manhole in the cylinder bottom.

Engines of this description have been made up to 90 horse-power.

As the effective area of the upper side of the piston is less than the lower, the steam has been used first above, and then allowed to pass below, where it acts expansively in giving the upward stroke.

Fig. 6697.



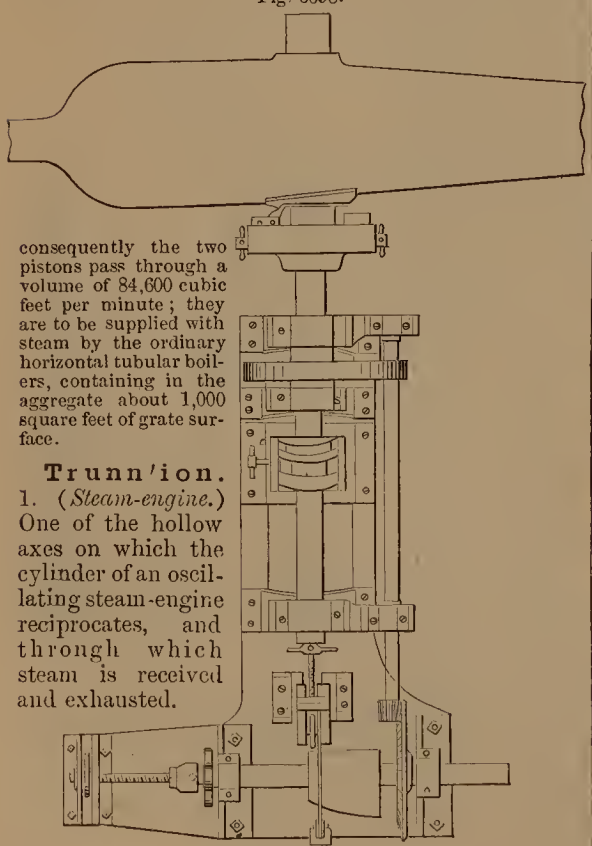
*Root's Trunk-Engine.*

See also Whitham's United States patent, September 4, 1841, using live steam on annular head, and expanding same steam on circular head See also Henderson's patent, April 5, 1870, No. 101,617. In Root's engine, August 7, 1866, No. 56,993, the piston is attached to an elongated trunk extending through both heads of the cylinder. The pitman passing through the trunk is attached to the end thereof most remote from the crank-shaft, and this end works in guides secured to the cylinder-head

The double-trunk engines constructed by John Penn and Sons, Greenwich, England, for the English iron-clad "Hercules," are said to be the largest pair of screw engines ever built. There are two cylinders, each 127 inches in diameter, by 4 feet 6 inches length of stroke of piston; the diameter of the trunks is 47 inches, whose area, being deducted, gives the pistons an effective diameter of 118 inches.

These engines are intended to run 60 revolutions per minute, consequently the two pistons pass through a volume of 84,600 cubic feet per minute; they are to be supplied with steam by the ordinary horizontal tubular boilers, containing in the aggregate about 1,000 square feet of grate surface.

Fig. 6698.



*Kaylor's Trunnion-Lathe.*

**Trunn'ion.** 1. (*Steam-engine.*) One of the hollow axes on which the cylinder of an oscillating steam-engine reciprocates, and through which steam is received and exhausted.

2. (*Ordnance.*) One of the cylindrical projections from the sides of a cannon or mortar, which rest in the *cheeks* of the carriage, forming supports for the piece and an axis on which it turns during elevation or depression. The trunnion is usually one caliber in diameter and length.

3. A general term for an axis of similar character to the above.

**Trunn'ion-lathe.** A machine-tool for turning off the trunnions of ordnance or oscillating steam-cylinders.

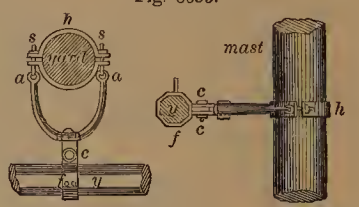
The machine employs a shaft, carrying a revolving cutter, which is susceptible of feed-motion to and from the axis of the shaft upon which it revolves. The shaft is arranged to slide up to and from the article to be planed, and is operated by a revolving former at its rear end, working upon a shaft at right angles to the one carrying the tool, which also has a sliding motion to bring the different parts of the former to act upon the tool-carrying shaft.

**Trunn'ion-ring.** A ring around a cannon next before the trunnions.

**Trunn'ion-valve.** A valve attached to or included in the trunnions of an oscillating-cylinder steam-engine, so as to be reciprocated by the motions of the cylinder.

**Truss.** 1. (*Nautical.*) The iron hoop, stirrup, and clasp by which the middle of a lower yard is secured to the mast.

Fig. 6699.



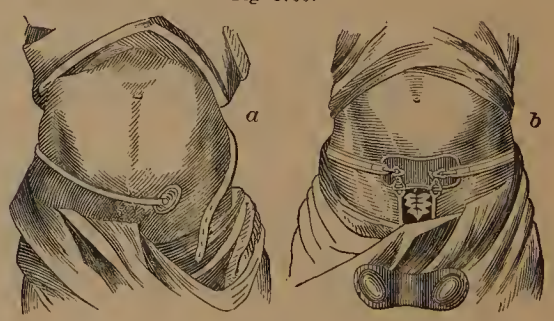

*Truss.*

It consists of a hoop *h* on the mast, tightened by means of the screws *s*, whose open heads engage the eyes *a* of the stirrup, which is swiveled to the hoop *f* on the yard *y*. The hoop *f* has jaws *c*, by whose closure it is tightened on the yard *y*. Upper yards are secured by a *parral*, a strap of rope or iron, fitting loosely around the mast, so as to slip readily up and down when the yard is raised and lowered.

2. (*Surgical.*) An instrument to keep hernia reduced, that is, to retain the intestines within the abdominal cavity. The essential feature is a spring or bandage resting on a pad, which is kept above the orifice of protrusion. The pad is usually kept to its seat by a spring which reaches around the body terminating opposite to the ruptured part. The spring is cushioned, and sometimes has pads to give it bearing on special parts.

*Advertisement in the "London Gazette,"* 1665: "Rowland Pepin, famous for the cure of *rupture* or *broken-belly* these fifty years, makes easy trusses of all kinds, and lives in Naked-boy Court, near Strand Bridge, without Temple-bar, London, where the poor may be relieved for charity."

Fig. 6700.



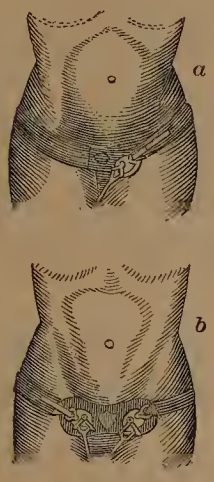

*Hernia Trusses.*

The moderu forms of truss are very numerous; a few are illustrated.

In Fig. 6700, *a* shows mode of application of the hard rubber truss in treatment of inguinal hernia. The spring is passed across the body from the well side, and the longest diameter of the adjustable pad is placed in the line of rupture.

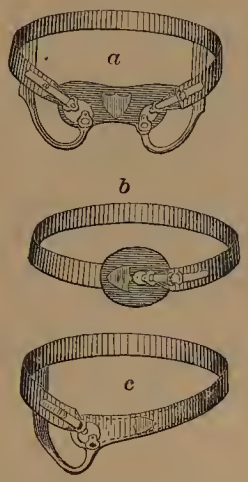
*b*, "hard rubber elastic night truss," useful in cases where from corpulency or otherwise there is a tendency to hernia. A stout elastic web passes around the body, and is attached to

Fig. 6701.




Trusses.

Fig. 6702.




Trusses.

the pad in front by metallic loops engaging studs on the pad; elastic bands pass from the body band, under the limbs, to studs upon the rupture pads.

Fig. 6701, *a*, left-side truss.

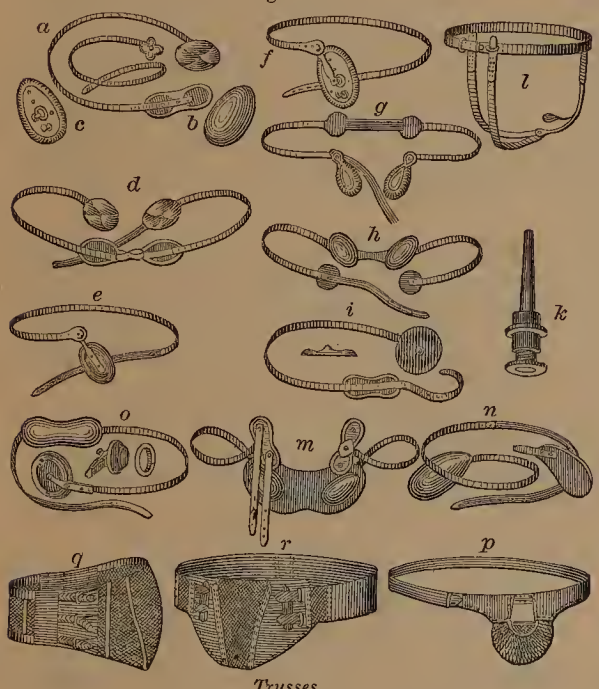
*b*, elastic abdominal supporter,— for preventing rupture,— adapted for those having constitutional tendeucy to hernia, or to be used while taking violent exercise.

Fig. 6702, *a*, double truss, with supporter-brace.

*b*, umbilical or *navel* truss.

*c*, single truss, with brace right side.

Fig. 6703.




Trusses.

Fig. 6703, *a*, single truss, for adults or infants.

*b*, convex pad, with ball and socket attachment.

*c*, convex pad, with ball and socket attachment, and set-screw for giving any desired position to pad.

*d*, double truss.

*e*, reversible pad single truss, applied from ruptured side, the pad having a sliding-arm attachment secured by set-screw.

*f*, truss similar to foregoing, with ball and socket and set-screw.

*g*, double truss, on the same plan as single trusses *e f*.

*h*, "Hood" pattern truss.

*i*, umbilical truss.

*k*, hard rubber pile pipe.

*l*, *prolapsus ani* supporter.

*m*, abdominal supporter.

*n*, "French" pattern truss.

*o*, combination pad truss.

*p*, suspensory, for supporting the scrotum in hydrocele, variocele, etc.

*q*, elastic abdominal belt.

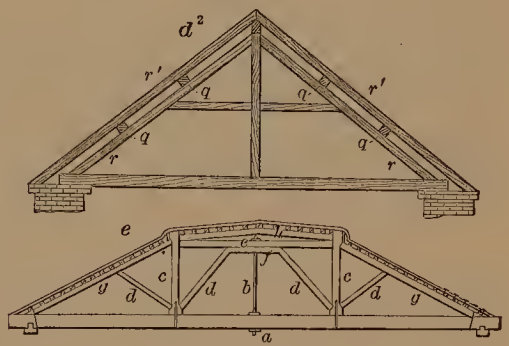
*r*, "Philadelphia" abdominal belt.

3. (*Carpentry.*) A frame to which rigidity is given by staying and bracing, so that its figure shall be incapable of alteration by turning of the bars about their joints.

The simplest frames are of wood and of few parts. More imposing structures are more complicated, the parts being employed in resisting extension or compression. Composite trusses employ both wood and iron; in fact, few of any importance are destitute of bolts and tie-rods. The principal simple forms are shown in Roof, Figs. 4420–23, pages 1971–73. Railway bridges of the present day exhibit many remarkable structures of this class. See Truss-bridge; also Tubular Bridge, and list under Bridge.

$d^2$, Fig. 6704, shows secondary rafters $r'$ $r'$, which are added to receive the sheathing, and connected to the principal rafters

Fig. 6704.




Roof-Trusses.

*r r* by purlins *q q*. The king-post is extended down to support the ceuter of the tie-beam, into which the principal rafters only are mortised.

In Fig. 6704, *e* is a queen-post wooden roof-truss at the Greenwich Hospital, England.

*a* is the tie beam, 57 feet long, spanning 51 feet clear.

*c c*, queen-posts.

*d*, braces.

*e*, truss-beam.

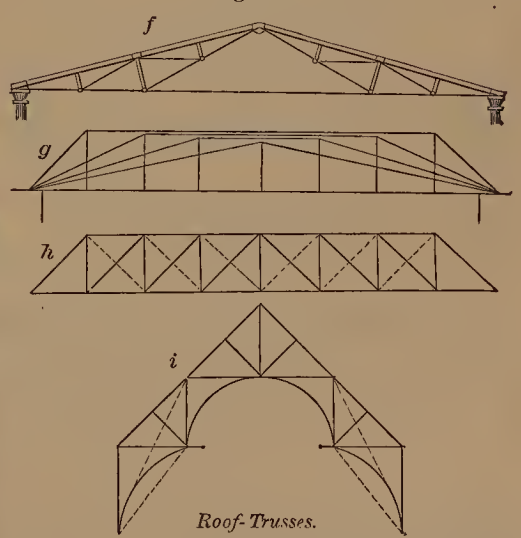
*f*, straining-piece.

*g*, principal rafters.

*h*, a cambered beam for the platform.

*b*, an iron string supporting the tie-beam.

Fig. 6705.




Roof-Trusses.

Fig. 6705, *f*, another form of secondary trussing for iron roofs.

*g*, compound bridge-truss, of timber; from the bridge at Schaffhausen.

*h*, lattice-truss; commonly used in timber bridges having abutments.

*i*, open truss; used in Gothic roofs. In this the lateral thrust is not entirely removed.

Fig. 6706.

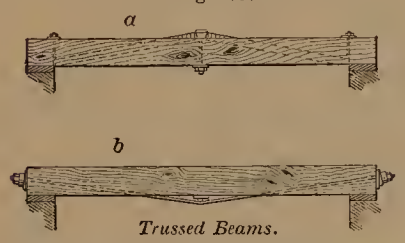
*Truss.*

4. (*Architecture.*) An ornamented corbel serving to support an entablature or balcony, or to conceal the ends of the beams which really support the structure; in the latter case it is frequently made of galvanized sheet-iron.

**Truss-beam.** An iron frame serving as a beam, girder, or summer.

A wooden beam or frame with a tie-rod to strengthen it against deflection. This trussing may be done in two ways: 1st, by inserting cast-iron struts, as in *a*, thus placing the whole, or nearly the whole, of the wood-work in a state of tension; 2d, by wrought-iron tension-rods, as in *b*, which take the whole of the tension, whilst the timber is thrown entirely into compression.

Fig. 6707.

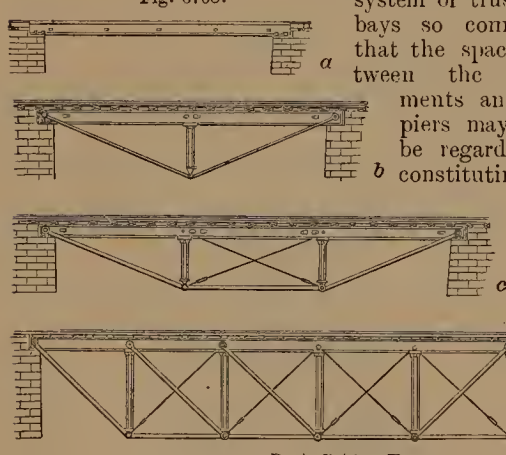



*Trussed Beams.*

For various other forms of truss, see BRIDGE; TRUSS; RAFTER; ROOF; TRUSS-BRIDGE; etc.

**Truss-bridge.** A bridge which depends for its stability upon the application of the principle of the truss. Short bridges of this class may be formed by a single truss; larger structures are composed of a system of trusses or bays so connected that the spaces between the abutments and the piers may each be regarded as constituting a single compound truss. Fig. 6708 shows several trusses for bridges of short span.

Fig. 6708.




*Deck-Bridge Trusses.*

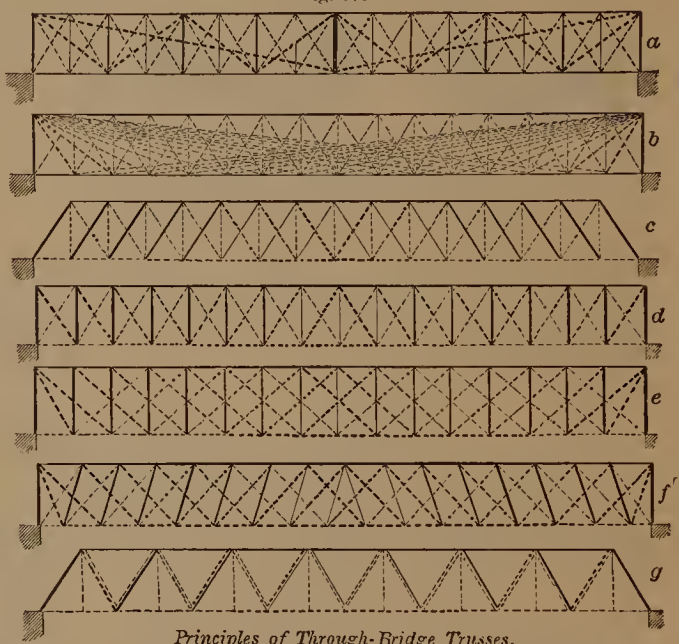
*a*, deck-truss for 30 feet span.
*b*, deck-truss for from 24 to 48 feet span.
*c*, deck-truss for 70 feet span.
*d*, deck-truss for 100 feet span.

The extensive use of wrought-iron is a characteristic feature in bridges of this kind, that material being generally employed in all parts which have to resist a tensile strain, and the various systems each aim to solve the problem of combining the maximum of strength with the minimum of lightness, by dispensing as far as possible with compressive forces, and relying as little as may be on the rigidity of materials.

Rider's, one of the earlier American forms, is composed of an upper and a lower chord, — the former of cast, and the latter of wrought, iron, — connected by upright posts of cast and diagonal braces of wrought iron, and has been successfully employed in bridges of moderate span.

In Fink's, which has been extensively used upon railways in this country, the foot of each principal strut, or king-post, is connected with the ends of the top-chord by a pair of diagonal bars which support the weight of one half the truss; each half-span is again subdivided by a strut and two diagonal tension-bars, extended one to the nearest end of the top-chord, and the other to the top of the center-post; each quarter-span is similarly divided into eighths, and these, again, for spans of more than 100 feet, into sixteenths.

Fig. 6709.




*Principles of Through-Bridge Trusses.*

In Bollman's truss, the load upon each panel is transferred to the end of the truss by a pair of suspension-bars. The former railroad bridge at Harper's Ferry was of this kind, having four parallel trusses for a double line, with a clear span of 124 feet, the span being divided into eight panels. The depth of the truss was 17 feet 6 inches, and with a weight of 122 tons, at a speed of 8 miles an hour, the deflection at the center is stated to have been but 1⅜ inches.

*a* (Fig. 6709), Fink system.
*b*, Bollman system
*c*, Howe or Jones system.
*d*, Murphy-Whipple system.
*e*, Linville system.
*f*, Post system.
*g*, system of triangles.

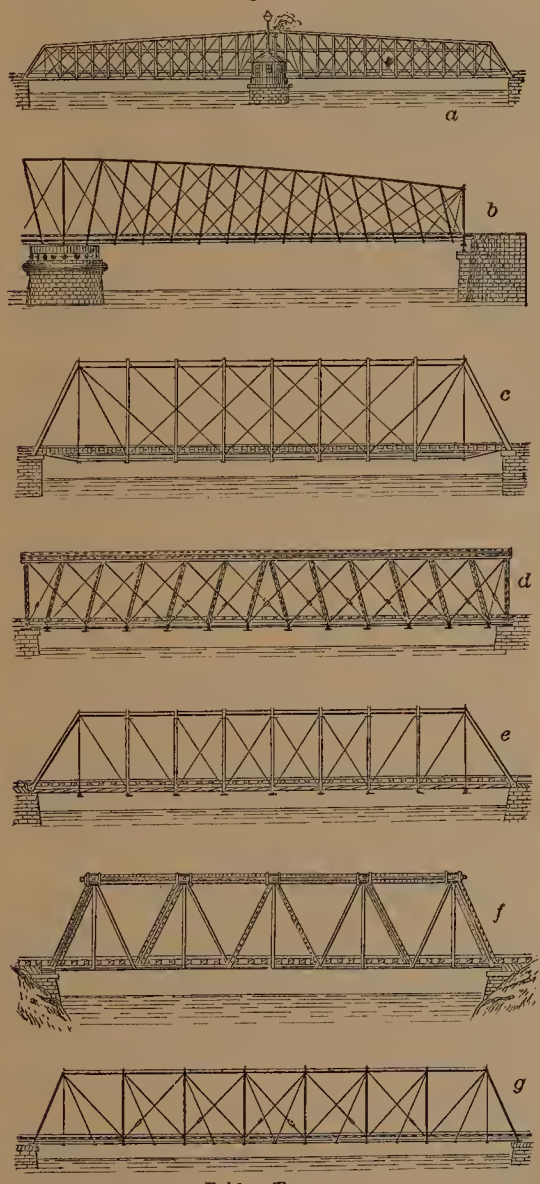
The Louisville railway-bridge is of iron trusses, and has
Piers..... 28.
Spans..... 29, from 30 to 400 feet.
Length of superstructure, 5,294 feet.
Hight above high water, 50½ feet.
Hight above low water, 101 feet.
Wood in superstructure, 610,000 feet, board measure.
Masonry in piers, 30,000 cubic feet.
Iron in bridge, 8,723,000 pounds.
Cost, $ 1,555,000.

The railway bridge of the Susquehanna, at Havre de Grace, was built from the plans of George A. Parker. Its cost was about $ 1,500,000. The work occupied about 1,000 men for 4 years. The piers which support the superstructure are 13 in number, and are of stone carefully laid in cement, within caissons of boiler-iron, which reach a point above the line of running ice. From this hight the piers are finished with cut-stone, laid in courses. The draw-pier is circular, with a diameter of 24 feet 8 inches at the top of the caisson, while each of the other piers has a width of 8 feet, and a length of 35 feet 4 inches at top of caisson, and a width of 7 feet 3 inches at top of cut-stone. Beside the piers which carry the superstructure, there are at the draw 2 guard-piers, one above and one below, which serve to protect the draw from injury, and to aid vessels in passing. It is substantially the Howe truss.

The bridge across the entrance to the Niagara River, at Black Rock, designed for the use of the Grand Trunk, Great Western, Canada Southern, New York Central, Erie, and New York West

Shore, and Chicago Railways, has a total length of 3,550 feet, 1,300 feet of which are over trestle-work upon Squaw Island, 450 feet over Black Rock Harbor, and the remainder over the main branch of the river. The river portion of the bridge has 8 piers and 2 abutments. Owing to the depth of water, from 12 to 45 feet, and a current of from 5½ to 10 miles an hour, varying with the state of the wind, considerable difficulty was experienced in the construction of the piers, which were founded upon caissons. Four of the spans are 190, and three others 240 feet wide, in the clear, and there are two draw-openings, each 160 feet wide. In Black Rock Harbor are two draw-openings, each of 90 feet, and a fixed span of 220 feet; these are supported on 2 piers and 2 abutments. The masonry is of sandstone, and the superstructure of wrought-iron, from the Phœnixville works, the whole amount of iron used being over 2,000 tons. The 190-foot spans weigh 130, and the 240-foot spans 208 tons each. After completion, one of the 190-foot spans was loaded with 210 tons of rails, equally distributed over the floor-beams, — a weight greater than that of a continuous line of locomotives covering the span, — and left in that condition for three days; the deflection amounted to but one inch, and, on the removal of the load, the truss resumed exactly its former position. The entire cost of the bridge was about $1,500,000.

Fig. 6710.

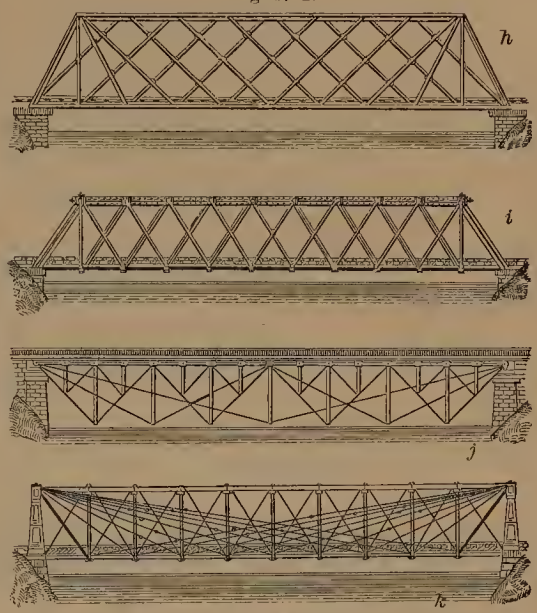



*Bridge-Trusses.*

Figs. 6710, 6711, show several forms of trusses adopted by the principal bridge-building firms in the United States. See also Iron Bridge.

*a*, Kellogg Bridge Company, Buffalo, N. Y.
*b*, American Bridge Company.
*c*, Phœnixville Bridge Company, Philadelphia.
*d*, Watson Manufacturing Company, Paterson, N. J.

Fig. 6711.

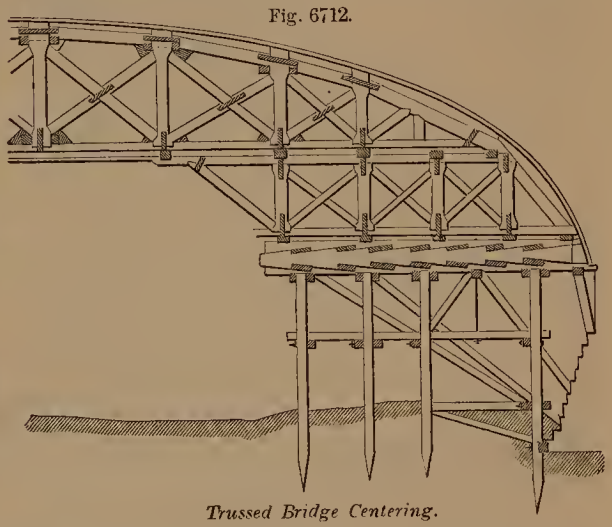



*Bridge-Trusses.*

*e*, Detroit Bridge and Iron Works, Detroit, Mich.
*f*, Baltimore Bridge Company, Baltimore, Md.
*g*, Kellogg and Maurice, Athens, Pa.
*h*, Niagara Bridge Works, Niagara, N. Y.
*i*, Macdonald, New York.
*j*, Louisville Bridge and Iron Company, Louisville, Ky.
*k*, Patapsco Bridge and Iron Works, Baltimore, Md.

**Trussed Gird'er.** A construction having special application in centering, as shown in the annexed

Fig. 6712.



*Trussed Bridge Centering.*

cut, which exhibits a portion of the centering of one of the London Bridge arches. See Truss.

**Trussed Roof.** One involving the principles of a truss; containing principals, purlins, struts, and ties. See Roof; Truss.

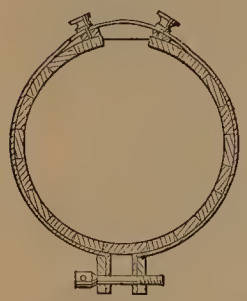
**Truss-hoop.** (*Coopering.*) One placed around a barrel to strain the staves into position, collapsing them toward the chine, leaving the bulge at the middle portion.

The example (Fig 6713) is a device for binding and preserving the integrity of the barrel when the hoops are removed, in order to replace a broken or decayed stave without removing the contents.

**Truss'ing-ma-chine'.** (*Coopering.*) One for drawing the truss-hoops upon casks, to draw the ends of the staves together at the chines. A *hoop-driving* machine.

**Truss-piece.** A piece of filling between compartments of a framed truss.

Fig. 6713.

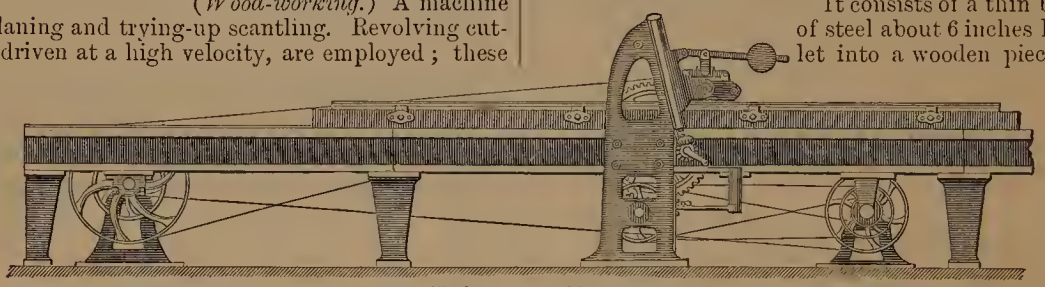


*Truss-Hoop.*

**Try'ing-plane.** (*Joinery.*) *Try-plane.* The second in order of fineness of the joiner's bench-planes. The first is the jack-plane, which prepares the surface. The *trying*-plaue is long, and levels the surface, *trying* it for straightness. It is succeeded by the *panel* and the *smooth* planes.

**Try'ing-square.** See TRY-SQUARE.

**Try'ing-up Ma-chine'.** (*Wood-working.*) A machine for planing and trying-up scantling. Revolving cutters, driven at a high velocity, are employed; these may be of suitable shapes for molding beading, rabbeting, etc. The stuff may be secured on the cast-iron feed-table by cramps at intervals of 3 feet, and the cutter-block carriage is provided with two pressure-rollers to keep down the stuff when the cramps are not required, and is raised or lowered by a handle in connection with two side-screws. The feed-motion is self-acting.



*Trying-up Machine.*

**Try'sail.** (*Nautical.*) A storm-sail of strong material and relatively smaller area.

A fore-and-aft sail set with a boom and gaff in ships. Similar to a *spencer*, *spanker*, *driver*. For the names of its parts, see FORE-AND-AFT SAIL.

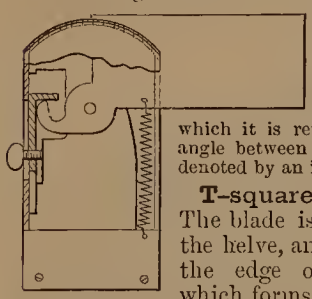
**Try-square.** An instrument used by carpenters and joiners for laying off short perpendiculars, etc.

Fig. 6714.



It consists of a thin blade of steel about 6 inches long, let into a wooden piece of similar length and securely fastened at right angles thereto, the edges of both being accurately straight. See SQUARE.

Fig. 6715.

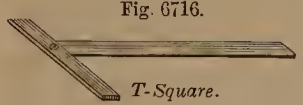


*Try-Square and Bevel.*

Fig. 6715 shows a try-square and bevel in which the pivoted blade is drawn in one direction by a spiral spring, and has a toe resting against the projection of an adjustable plate, by which it is retained to any angle. The angle between the head-bar and blade is denoted by an index-plate.

**T-square.** A draftsman's ruler. The blade is set at right angles to the helve, and the latter slips along the edge of the drawing-board, which forms a guide. The helve is made of two parallel pieces, in one of which the blade is mortised. The other portion of the helve is adjustable on the set-screw to any angle, so as to rule parallel oblique lines, or to form an oblique base for the triangles, which are the usual rulers in plotting and projecting.

Fig. 6716.



*T-Square.*

Fig 6716 has a shifting member on one side of its tongue, so as to give the latter any angle with the base line of the drawing. The tangent-screw and protractor admit accurate augular adjustment.

**Tub.** 1. (*Domestic, etc.*) A small cask, half-barrel, or piece of cooper work, with one bottom and open above; as a *wash*-tub, *meal*-tub, *mash*-tub, etc.

2. (*Mining.*) *a.* A corve or bucket for raising coal or ore from the mine.

*b.* A casing of wood or of cast-iron sections bolted together, lining a shaft.

3. (*Metallurgy.*) One form of chamber in which ore or slimes are washed to remove lighter refuse. See JIGGER; FRAME; TRUNK; etc.

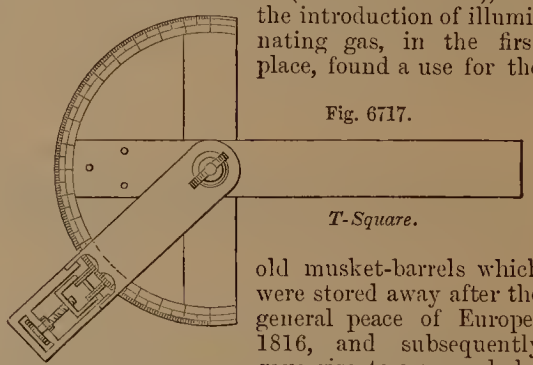
**Tu'ba.** (*Music.*) A brass wind-instrument, the lowest as to pitch in the orchestra. It has five cylinders, and its compass is four octaves.

**Tub'bing.** (*Mining.*) Lining a shaft with casks or cylindrical caissons, to avoid the caving in of the ground. Especially used in shafting through quicksand. See CAISSON.

**Tube.** 1. A metallic pipe, of many kinds and uses.

The first wrought-iron tubes made on a large scale were for barrels of fire-arms (see GUN-BARREL), but the introduction of illuminating gas, in the first place, found a use for the old musket-barrels which were stored away after the general peace of Europe, 1816, and subsequently gave rise to a general demand for tubing of various lengths and sizes, for which the old barrels would have been unsuited had they not already been exhausted.

Fig. 6717.



*T-Square.*

Under Russell's patent, 1824 (English), the tubes were first bent up by hand-hammers and swages, to bring the edges near together, and then they were welded between semicircular swages, fixed respectively in the anvil and the face of a small tilt-hammer worked by machinery, by a series of blows along the tube, either with or without a mandrel. The tube was completed by being passed between rollers, with half-round grooves, which forced it over a conical or egg-shaped piece at the end of a long bar, to perfect the interior surface.

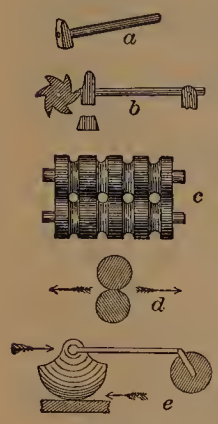
Various improvements were afterward made, as, for instance, bending the skelps, first to the semi-cylindrical and then to the tubular form, preparatory to welding, by swage tools, worked by machinery. The whole process was afterward carried on by rollers, which were abandoned on account of the difference in velocity between the greatest and least circumferences of the rollers.

Subsequently, the plan was adopted of bending the end of the skelp to the circular form, and heating the whole skelp to a welding heat in a furnace. It is then dragged by the chain of a draw-bench through a pair of tongs, with bell-mouthed jaws, which are opened at the moment of introducing the skelp. No mandrel is employed. By this means wrought-iron tubes, from $\frac{1}{4}$ inch diameter and $\frac{1}{10}$ inch bore up to those of 6 inches internal diameter and $\frac{1}{8}$ to $\frac{3}{8}$ inches thick, are made with a perfect weld.

The following table shows the progress of invention in this direction: —

Draw-bench introduced into England.....1565
Rolls invented for rolliug iron, by Henry Cort.....1783
Draw-bench and rolls used for making lead-pipe, by Wilkinson.....1790
Combination of 2, 3, or more pairs of rolls, by Hayledine..1798

Fig. 6718.




*Principles of Action of Tube-Making.*

*Welding.*

*a*, hand-hammer.
*b*, power-hammer.
*c*, rolls with several passes.
*d*, alternating holes.
*e*, segment moving on a bed.
*f*, three or four rolls making one hole.
*g*, drawing through holes or tongs.
*h*, drawing through rolls.

*Finishing.*

*i*, draw-bench and rolls.
*j*, draw-bench and rolls.

*Drawing over a Mandrel.*

*k*, no mandrel.
*l*, parallel and in motion.
*m*, taper and in motion.
*n*, enlarged end and at rest.

*Form of Joint.*

*o*, but or jump.
*p*, scarf or lap.

The excellence attained in making tubes has been owing to the persistent attempts at perfection in manufacturing two articles, — gun-barrels, and tubes for steam-engine boilers and condensers.

The series of English patents on this subject may be thus enumerated, — the letters in parentheses have reference to the diagram, Fig. 6718: —

Cook, 1808 (*a i j l p*). 1. Forge a round bar, drill a hole longitudinally; elongate by draw-plates, or grooved rollers, over a mandrel.

2. Turn a skelp over a mandrel; weld, and draw as before.

3. Force a circular plate of iron through a series of holes in a die, giving it a cup-shape, which is eventually opened at bottom and elongated to a cylinder, by drawing as before.

James and Jones, 1811 (*b c m p*). 1. The heated skelp is turned over a mandrel, and swaged by a hammer, while resting in a grooved anvil.

2. Welded and rolled by grooved rollers.

Osborne, 1817 (*b c d e n p*). The skelp is turned and welded on a mandrel, which has a shield to prevent its passing between the rollers, so that the barrel is drawn off the mandrel. This is repeated with progressively smaller mandrels and grooves.

Russell, 1824 (*b j k l o*) The skelp welded by grooved anvil and top tool.

Whitehouse, 1825 (*g k o*) The skelp was turned into position for welding, and was then drawn between dies, or passed between grooved rollers, without mandrel or internal support.

Royl, 1831 (*c i k o*). Two grooved rollers, which received bent and heated skelp, and drew it out of the mouth of the furnace.

Harvey and Brown, 1833 (*c n o p*). The mandrel was a short instrument, just in front of the rollers, so that the enlarged head came just beyond the pinch of the rollers. In working, the heated tube was forced over the short, cranked stem of the mandrel, the unelosed seam of the tube being sufficiently open to allow it to pass the fin by which the stem of the mandrel was carried.

Russell, 1836 (*h i j k o*). The end of the skelp being turned around, so as to make the edges lap, it is pulled at a welding heat between dies, or rollers, without a mandrel or central support.

Prosser, 1840 (*f n o p*). Four rollers, each having a groove equal to the quarter of the circumference, and driven by gearing, so as to travel at the same velocity. The end of the skelp was bent around, entered between the rollers, and discharged on to a straight mandrel, smaller than the bore.

Cutler, 1841 (*g h i k n o p*).

Russell Whitehouse, 1842 (*g l p*). The skelp, bent into an oval form, was placed on a small mandrel, which filled it across the minor diameter. The pressure was applied at the other edge of the lap, then at the inner, and lastly in the middle. Drawing between dies restored the circular form and loosened the mandrel

Russell, 1845. The edges of the skelp are lapped on a long bar, which is then drawn beneath a grooved roller, to close the weld.

Banister, 1849. Has a combination tube, brass inside, then iron, copper outside, so that the former is exposed to the fire, the copper to the water, and the iron stiffens both. The annealed tubes, of proper size, are telescoped, and then drawn between dies, to elongate and attenuate them.

Ostrander's tubular iron is rolled with a compound mandrel, 30 feet long, of required diameter and shape, and with a hole from $1\frac{1}{16}''$ to any required size. It is used for stay-bolts for boilers, where it indicates, by leaking into the fire, if the bolt-head has given way; also used for hollow pump-plungers, etc.

Fig. 6720 is a machine for making sheet-metal tubes from blanks or skelps. A series of pairs of rolls is used in connection with a stationary mandrel of peculiar shape, by which the sheet of metal is first bent to the form of a trough, with one edge higher than the other; then into a tube, with its marginal surfaces bent up and in contact. The projecting edge is next bent over, and, lastly, the lap is bent down upon the tube and flattened.

Telescope-tubes are made of brass skelps, turned over and soldered. They are then forced on to a steel mandrel and drawn through a die.

Fluted tubes are drawn through ornamental dies of the required form. The mandrel is frequently cylindrical.

Joint wire is a fine tube used by silversmiths and watch-case makers. A small pipe is threaded on a piece of steel-wire, and both are drawn through a die, like a piece of solid wire. See PIPE; LEAD-PIPE.

For *lead-pipe making* and *lining with tin*, see pages 1271, 1272.

For *making of gun-barrels*, see pages 1032, 1033.

For *bushing*, see page 413.

See also PIPE, pages 1707, 1708, and list under that head.

For tubing for oil-wells, see WELL-TUBING.

Fig. 6719.

*Flexible Tubing.*

2. India-rubber tubes are made: —

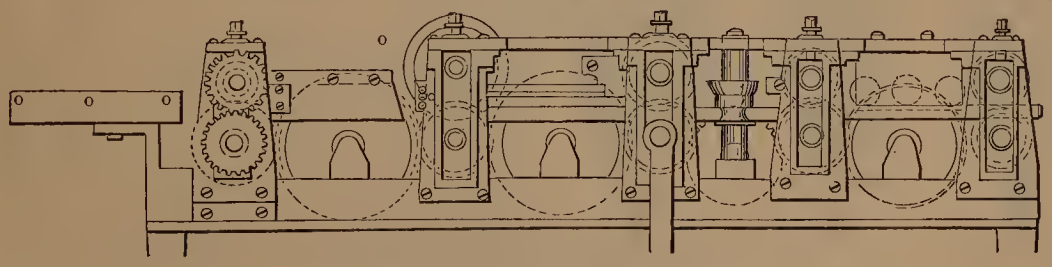
1. By wrapping slips of rubber or rubber-cloth around a mandrel of glass, which is afterward withdrawn, the layers and the edges being joined by solvents or heat.

2. By driving the pastry mass out through an annular die-opening, in the manner of making LEAD-PIPE (which see).

The flexible tube (Fig. 6719) has a framework of flattened wire, wound spirally round a mandrel. This tube or coil is then covered with a braided or woven coating saturated with oil or varnish. Another coating of a narrow strip of leather is then wound spirally over this and oiled or varnished, over which is woven or braided another coat which forms the outside, and which is then oiled or varnished. The mandrel is then withdrawn from the finished tube.

3. (*Ordnance.*) A primer for ordnance. A small cylinder placed in the

Fig. 6720.



*Machine for Making Sheet-Metal Tubes.*

vent of a gun, and containing a rapidly burning composition, whose ignition fires the powder of the charge. See PRIMING-TUBE.

The *friction-primer* or *friction-tube* is a variety of *priming-tube*. See FRICTION-PRIMER.

4. (*Hydraulics.*) The barrel of a chain-pump.

5. (*Steam.*) A pipe for water or fire in a steam-boiler. It would be well to call water-pipes *tubes*, and fire-pipes *flues*, if it were not too late to attempt careful nomenclature now. The present practice is to call them flues or tubes, according to their relatively large or small diameter respectively. See TUBULAR BOILER.

Fig. 6721.

*Tube-Brush.*

Tubes, in locomotive-boilers, are of brass or iron, about two inches outside diameter. They extend between the tube-sheets of the boiler, and are fixed in them by ferrules driven in at each end, which make them steam-tight.

6. (*Surgical.*) *a.* An esophageal tube, capable of being passed into the stomach.

*b.* An elastic gum tube passed *per ano* into the colon, to discharge air or introduce enema.

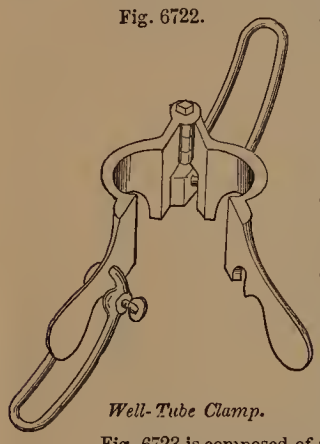
*c.* A tracheal tube.

**Tube-brush.** (*Steam.*) A wire brush for cleaning fire-tubes (flues) of steam-boilers.

Stillwell's tube-brush, patented March 20, 1864, has a screw-shank at one end and an eye at the other, so that it may be operated by pulling and pushing from the respective ends of the tubes.

The wires are flat on the ends, so as to act as cutters, and are soldered to the shaft, which consists of a twisted rod between whose strands the wires are held. The bottle-brush has a similar construction, with bristles instead of wires.

Fig. 6722.



*Well-Tube Clamp.*

**Tube-clamp.** (*Well-boring.*) A device used in lifting and withdrawing well-tubing. It has a pair of jaws which are tightly clamped around the tube, and a bail to each jaw, for the engagement of the hook of the tackle.

**Tube-clean'er.** (*Steam.*) A device for cleaning the interior of boiler and other tubes.

Fig. 6723 is composed of two spiral coils of steel wire, both coils being spirally arranged around and connected with a central twisted stem, having a screw-thread at one end for the attachment of a handle, and a loop at the other, through which a cord may be passed for the purpose of drawing it through the tube.

Fig. 6723.

*Steel-Wire Tube-Cleaner.*

Fig. 6724.

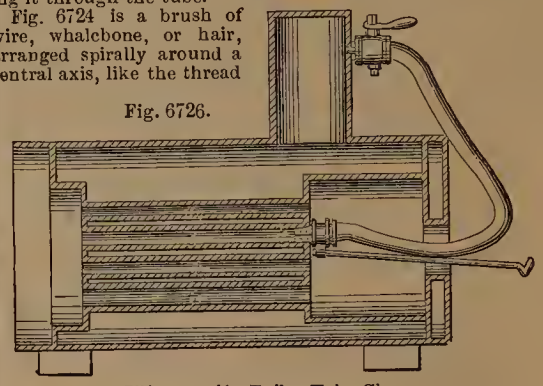
*Tube-Cleaner.*

Fig. 6725.

*Steel-Spring Tube-Cleaner.*

Fig. 6724 is a brush of wire, whalebone, or hair, arranged spirally around a central axis, like the thread of a screw; used for cleaning out tubes.

Fig. 6726.



*Illingworth's Boiler-Tube Cleaner.*

The boiler tube-cleaner (Fig. 6725) consists of a number of flat steel springs, which have a spiral twist and act as scrapers. These are secured between two caps on a screw-threaded rod. By varying the distance of the caps, the scrapers are elongated or spread out to fit tubes of varying bores.

Fig 6726 shows a flexible pipe aud nozzle for blowing steam through the tubes for removing soot and scale. McDowell, March 6, 1866, uses jointed pipes for the same purpose.

**Tube-clip.** A kind of tongs used for holding test or other heated tubes in chemical manipulations.

Fig. 6727.

*Tube-Cock.*

**Tube-cock.** A species of cock consisting of an india-rubber tube, which is fitted within a pipe and compressed by a screw-valve when it is desired to stop the flow of liquid.

**Tube-com'pass.** A draftsman's compass, having tubular legs containing sliding extension-pieces adjustable to any required length by means of set-screws. One leg carries a reversible needle-point and pencil-holder, and the other a reversible needle-point and pen.

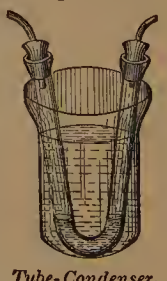
Fig. 6728.

*Tube-Compass.*

**Tube-con-dens'er.** A bent tube, provided with a stopper at each end, through which a small tube is inserted; used in obtaining solutions of ammonia and other gases which are absorbable in water.

**Tube-cut'ter.** A device for cutting gas and other metallic pipes. The example (Fig. 6730) has a fixed jaw which grasps the pipe, and a slider which carries a rotary circular cutter and is advanced by a screw, while the instrument is turned about the pipe by means of its handle. See also PIPE-CUTTER, page 1711.

Fig. 6729.



*Tube-Condenser.*

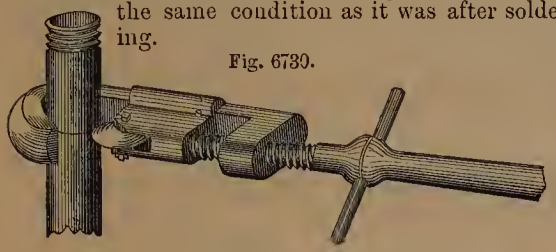
Fig. 6731 is a special tool for cutting off boiler-tubes when their exterior cannot be reached. The lower end of the stock is inserted into the tube; the tool projects radially from the revolving-stock and cuts off the boiler-tube from the inside.

**Tube-door.** (*Steam.*) A door in the outer plate of a smoke-chamber, which may be opened to allow the tubes to be examined or cleaned.

**Tube-draw'ing.** Metallic tubes are drawn in a manner similar to that employed for wire. Many

brass tubes for common purposes are bent, and, having the edges soldered together, merely drawn through a hole, which makes them tolerably round and smooth on the exterior, leaving their interior in the same condition as it was after soldering.

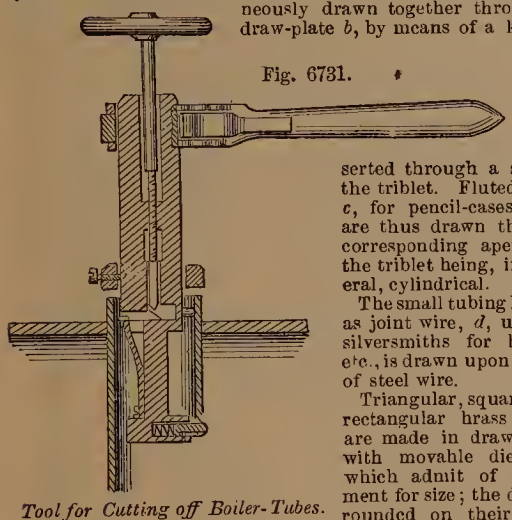
Fig. 6730.



*Roller Tube-Cutter.*

Sliding-tubes, for telescopes, etc., are *drawn inside and out*, rendering them very hard and inelastic, by inserting within them a steel cylinder, or triblet *a*, and setting down the end upon the shoulder of the triblet, so that they may be simultaneously drawn together through a draw-plate *b*, by means of a key inserted through a slot in the triblet. Fluted tubes *c*, for pencil-cases, etc., are thus drawn through corresponding apertures, the triblet being, in general, cylindrical.

Fig. 6731.



*Tool for Cutting off Boiler-Tubes.*

The small tubing known as joint wire, *d*, used by silversmiths for hinges, etc., is drawn upon a piece of steel wire.

Triangular, square, and rectangular brass tubes are made in draw-plates with movable dies *e f*, which admit of adjustment for size; the dies are rounded on their inner edges, are contained in a square frame, with adjusting screws, and the whole lies against a solid perforated plate.

Tubes of small diameter are generally completed in two drafts; sometimes three are used, by which time the maximum degree of hardness is attained.

When finished, the triblet is withdrawn by inserting the key at its other end and drawing it through a collar which exactly fits it.

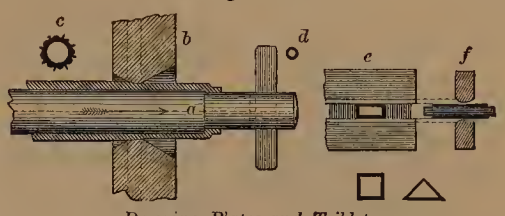
Large tubes are drawn vertically by means of a chain wound upon a barrel, turned by gear-wheels, as in a crane. This is the case with Donkin's machine for drawing the cylinders used in paper-making and other machinery, having a diameter of 26½ inches, and length of 6½ feet; a vertical screw is used, the nut of which is turned by toothed wheels, driven from a windlass.

Lead and tin pipes are cast in tubular form, and afterward drawn out upon triblets. The same course is adopted with brass boiler-tubes, which are sometimes drawn upon a taper-triblet, so that the tube may be thicker at the more exposed end, or that next the fire-box.

Rand's collapsible tin tubes, for artists' colors, having a thickness of but $^{1}/_{170}$ of an inch, were formerly drawn out in this way from the hollow cast pipe, the ends being cast and soldered in; for this purpose ten drawings were required, which were, however, owing to the ductility of the metal, conducted as one continuous operation.

At present, they are formed by a screw, or hydraulic press. A disk of tin having the external diameter of the intended tube is punched out, disked, and perforated by one blow. The blank thus formed is converted into a finished tube by a second blow between two dies, the lower one of which has a hollow cylindrical cavity of the same diameter as the blank, and terminates in a hollow screw; the upper die is a cylinder of greater length than the tube, and having a small tapering spindle. The cylinder is just so much smaller than the lower die as to leave an annular space equal to the intended thickness of the tube.

Fig. 6732.

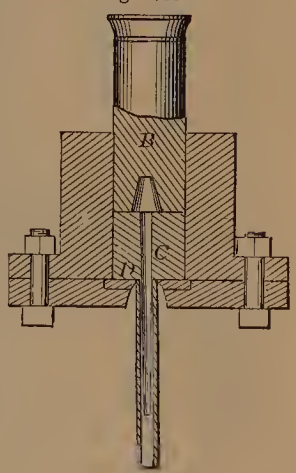



*Drawing-Plates and Triblets.*

When the two dies are brought together, the tin instantaneously flows through this annular aperture up and around the cylindrical mandrel, almost after the manner of a fluid, forming the body of the tube, while the nozzle, with its screw to receive the cap, is shaped by the screw and spindle. The ascent of the cylinder leaves the tube behind, and the screwed extremity of the mold is then driven up by a ram and lever from below, forcing up the tube, which is left free by the screwed portion of the mold dividing into two halves. See also LEAD-PIPE.

In Fig. 6733, a tapering mandrel *C* fixed in the ram *B* is employed in conjunction with the die *D* to form leaden tubes of uniform exterior diameter, but having a tapering bore, for water-pipes, which have to resist a greater pressure toward their lower ends. The pipe and its mandrel pass down together, and the former is cut off, and removed when the stroke is over; the smaller end of the mandrel being downward, the tube slips off.

Fig. 6733.

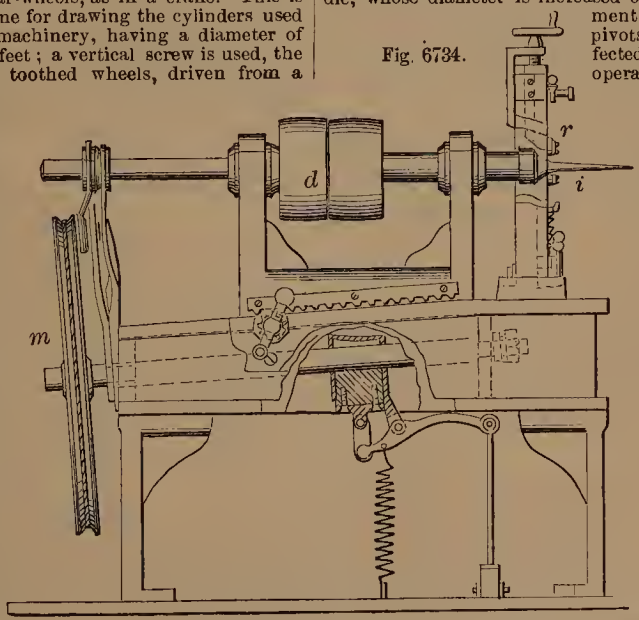



*Taper-Tube Press.*

The machine (Fig. 6734) has a *spinning* action, and is intended for forming tapering pipes, such as spouts or nozzles, from hollow cylinders of block metal. The cylinder is placed upon the spindle *i*, to which a rotary and backward movement is imparted by the pulleys *d m*, while the tool *r* is pressed against the metal, spinning it into tapering form corresponding to that of the mandrel.

In Fig. 6735, the faces of the series of *wordles* form a circular die, whose diameter is increased or diminished by the movement of the *wordles* upon their pivots. This movement is effected by a rack and gearing operated by the longitudinal movement of the dies.

Fig. 6734.




*Machine for Spinning Tapering Tubes of Sheet-Metal.*

**Tube-ex-pand'er.** (*Steam.*) A tool for setting the *tubes* in the *tube-sheets* of locomo-

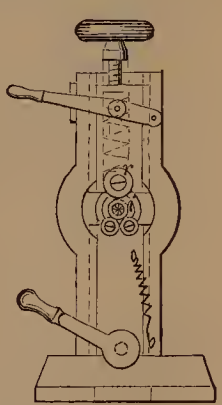
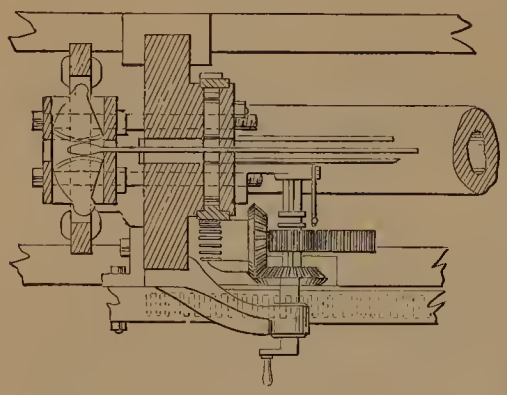


Fig. 6735.

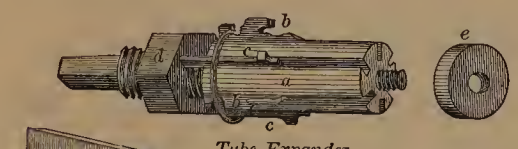


*Harding's Machine for Drawing Tapered Tubes.*

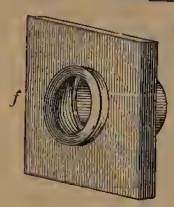
tive and other similar boilers. A collar is formed on the tube by expansion, on the inner or water side of the sheet, and the ends of the tube are then turned over upon the sheets at the fire-box and the smoke-box ends respectively. The collar and outer flange thus formed constitute the water and steam-tight joint by which each tube is secured to the sheets.

The mandrel *a* has several longitudinal grooves whose bottoms form inclined planes in which the beading dies *b b* and upsetting dies *c c* slide. The mandrel is inserted in the end of the tube, and the beading dies are pushed in until the ends of their projecting arms, which are exterior to the tube, bear against the face of the tube-sheet. The mandrel is then turned by a wrench which is slipped over its square projecting shank, the

Fig. 6733.




*Tube-Expander.*




*Tube in Tube-Sheet.*

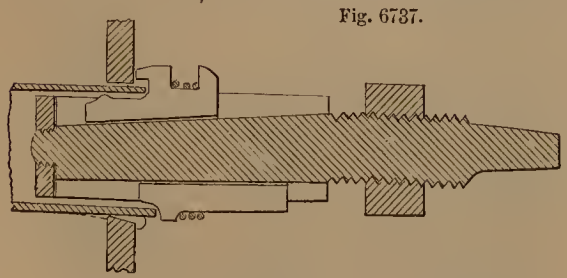
interior projections on the dies *b* expanding the tube so as to form a collar. By turning the nut *d* the dies *c c* are forced against the projecting end of the tube, upsetting it against the face of the tube-sheet. *e* is a ring which is screwed on to the end of the mandrel to prevent the dies from slipping out of their grooves when the tool is not in use.

*f* is part of the tube-sheet with a tube inserted as described.

**Tube-fas'ten-er.** (*Steam.*) A machine for fastening tubes in *tube-sheets*, by expanding them against the edge of the hole to make a steam-tight joint.

The cylindrical mandrel or shank has a number of longitudinal grooves in its periphery, increasing in depth from its outer to its inner end, the bottom of the grooves forming a

Fig. 6737.



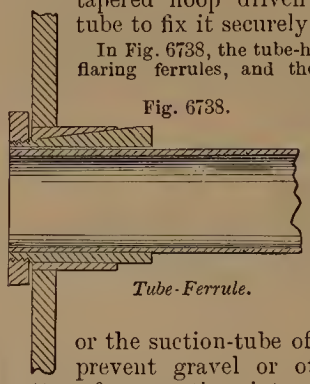
*McConnel's Tool for Fastening Boiler-Tubes.*

tapering or wedge-shaped foundation for a corresponding number of bits or sliding dies, part of which are for forming the bead on the tube inside of the tube-sheet, the other for flanging or turning out the end of the tube against the sheet.

**Tube-fer'rule.** (*Steam.*) A short sleeve for fastening tubes in tube-sheets. Usually a slightly tapered hoop driven in at the end of the tube to fix it securely in the boiler.

In Fig. 6738, the tube-holes are bushed with inward flaring ferrules, and the tube end is surrounded with a ferrule whose outward surface is brought in contact with the inner surface of the bushing by a nut screwing on its outer end.

Fig. 6738.



*Tube-Ferrule.*

**Tube-fil'ter.** (*Wells.*) A foraminous chamber at the end of a driven well-tube, or the suction-tube of a pump, to prevent gravel or other foreign matters from getting into and choking the pump.

Fig. 6739.

*Tube-Filter.*

That shown in Fig. 6739 is composed of sections of any kind of common wire, arranged in a tubular form, forming an open grate. The ends of the wire sections are welded together and form a drill. It relates to that class of wells formed by driving a tube into the earth and allowing it to remain.

**Tube-flue.** (*Steam.*) A furnace-tube through which flame passes.

A *tube* in a furnace, properly speaking, is traversed by water; a *flue*, by fire.

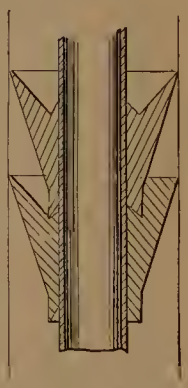
**Tube-pack'ing.** (*Wells.*) A bag of flaxseed or ring of rubber to occupy the space between the tube of an oil-well and the bored hole, to prevent access of water to the oil-bearing stratum.

In Fig. 6740, it consists of an elastic tube embracing the pump-barrel; its upper end, being flaring, expands under the pressure of water from above, and is thus pressed into the irregularities of the shaft.

**Tube-plate.** (*Steam.*) A sheet into which fire-tubes are set. See STEAM-BOILER FURNACE; TUBE-SHEET.

**Tube-plate Stay.** (*Steam.*) An iron rod passing across the boiler and having heads or nuts on the outsides of the respective sheets to tie the plates together and prevent their disruption by the pressure of steam.

Fig. 6740.



*Moulton's Oil-Well Pump-Packing.*

**Tube-plug.** (*Steam.*) A tapered plug of iron or wood, used for driving into the end of a tube when burst by the steam.

**Tube-plug Ram.** (*Steam.*) A long rod with a socket end, into which the plug fits, and is thus driven into the burst tube, and the plug-ram withdrawn.

**Tube-pouch.** The artillery-man's leather pouch for carrying friction-primers. It has two loops, by which it is fastened to the belt. The *priming-wire* and gunner's gimlet are carried with it.

**Tube-re-tort'.** A retort made from a glass tube, closed at one end, and sometimes having a swelled bulb.

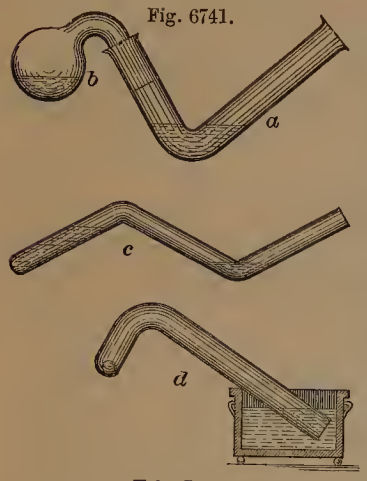
*a* (Fig. 6741), Clark's retort, and *b*, receiver, for the distillation and condensation of small quantities of acid.

*c*, Faraday's retort and receiver in one piece.

*d*, Gay Lussac's bent-tube retort, used when a solid is to be heated in a gas confined over mercury.

**Tube-scal'er.** (*Steam.*) A tool for removing soot and incrustation from the insides of flues of

Fig. 6741.




*Tube-Retorts.*

steam-boilers. See TUBE-CLEANER.

**Tube-scrap'er.** (*Steam.*) An implement for removing rust, sediment, etc., from boiler and other tubes.

The example is adapted for attachment to piece of gas-pipe as a handle. The blades, which are curvilinear in outline, are expanded by springs. See TUBE-SCALER; TUBE-CLEANER.

**Tube-sheet.** (*Steam.*) A boiler-plate into which the ends of boiler tubes or flues are inserted securely. See FLUE-BOILER; TUBULAR BOILER; STEAM-BOILER; etc.

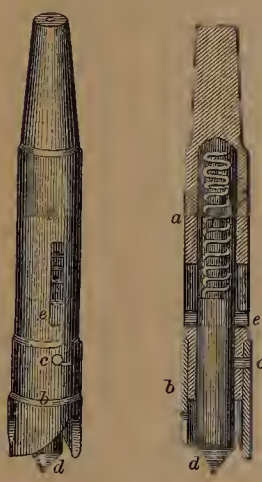
Fig. 6742.

*Tube-Scraper.*

**Tube-sheet Cut'ter.** (*Steam.*) A tool for cutting holes to receive the tubes in the tube-sheets of boilers. Fig. 6743 is designed to obviate the preliminary labor of drilling holes to receive the pin by which the cutter is usually steadied.

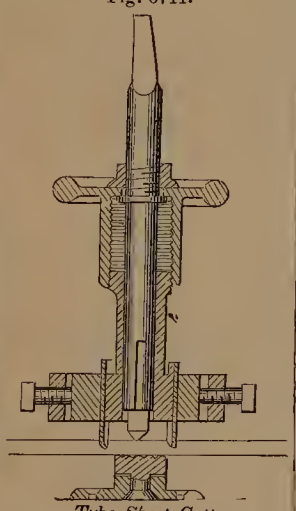
The socket *a* may be fitted in the drilling machine in the usual way. It carries a circular cutter *b* secured by the lantern lock-pin *c*. The center *d* is retained in the socket by the key *e*, and is pressed outward with sufficient force to resist lateral displacement by means of the spring *f*, but yields to the pressure by which the cutter is advanced to penetrate the sheet.

Fig. 6743




*Tube-Sheet Cutter.*

Fig. 6744.



*Tube-Sheet Cutter.*

Fig. 6744 is on the principle of the center-bit, the tool turning on a point while the cutters take a disk out of the plate. The cutters are adjustable to and from the center-pin to vary the size of hole, and are held in a sleeve which slips upon the mandrel, being fed by a screw as the cutters revolve, to force them against the metal.

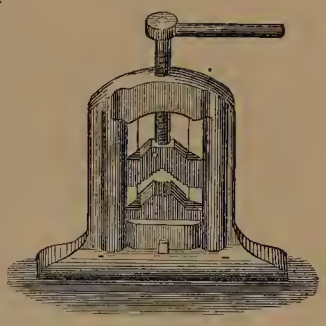
Fig. 6745.

*Tube-Stopper.*

**Tube-stop'per.** (*Steam.*) A device for plugging boiler, condenser, or other tubes in case of leakage or for other reasons.

That shown consists of an expansible ring *a*, two frusto-conical disks *b c*, a bolt *e*, and nut *f*. The device is inserted into the end of the tube, and the square-ended foot of the bolt is turned by using a wrench, causing the two disks to approach each other and expand the ring *a*, so as to fill the bore of the tube. A *tube-plug*.

Fig. 6746.



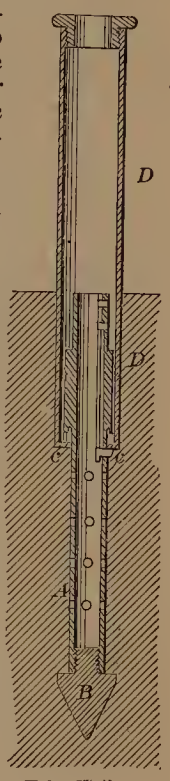
*Tube-Vise.*

**Tube-vise.** One for grasping tubes and pipes. See PIPE-VISE.

Fig. 6746 is an English tube-vise, designed to be attached to a bench. The pipe is clamped between the serrated jaws by the depression of the screw.

**Tube-well.** An iron pipe of small diameter, pointed, and having a number of lateral perforations near the end, driven into the earth by a small pile-driver hammer until a water-bearing stratum is reached. Where the depth exceeds 14 feet, two or more sections of pipe are screwed together. A small pump is attached to the top. The device is said to have been originally used in America for obtaining brine; but in what may be termed its domestic form, it was invented by Colonel Nelson W. Green, of the 76th Regiment, New York Volunteers, when stationed at Cortland, N. Y., 1862.

Fig. 6747.




*Tube-Well.*

In Minneapolis, a supply of water for extinguishing fires is obtained in localities beyond the reach of the city water-works by sinking four drive-wells at distances 15 feet from a center. The pipes (2½ inches) of the four wells are brought together at the top, where the suction-hose of the fire-engine is attached.

In Fig. 6747, the tube *D* is imperforate, and contains a smaller perforated tube *A*, having an enlarged conical head *B*, which, in driving, rests against a collar *c c*, at the bottom of the exterior tube.

An enlarged water-chamber is thus formed, and, when a sufficient depth is reached, the tube *D* is lifted, leaving the tube *A* protruding, in which position it is held by a spring-catch, its sides being free from the surrounding ground.

**Tub'ing.** Length of tubes, as well-tubing; or kind of tubes, as brazen, leathern, or flexible tubing.

**Tub-ma-chine'.** The machinery of a cooper's shop embraces the following: —

Lathe, for three sizes.
Matcher.
Bottom-planer.
Bottom-lathe.
Hoop-punch.
Cast-steel hoop-rolls.
Ear-punch.
Irons for making tub-ears.
Paint-reels.
Sand-papering pad.
Riveting-horn.
Shears for cutting wire.
Paint-mill.
Setting-up plate.
Patent hoop driver.
Spoke-shaves.
Chisels.
Churn-lathe.
Churn-matcher.
Hollow mandrel to turn rods.
Machine to cut the screws.
Lathe to turn covers.
Butter-tub lathe.
Butter-tub matcher.
Lock-cutter for hoops.
Kit-lathe.
Kit-matcher.
Keeler-lathe, for five sizes.
Keeler-matcher, for five sizes.
Piercing-bench for bottoms.
Bottom-jointer.
Pail-ear machine.

**Tub-saw.** A cylindrical saw for cutting staves from a block, giving them the transversely rounded shape. See CYLINDRICAL SAW; BARREL-SAW.

**Tub'u-lar-arch Bridge.** A bridge supported by a tubular archway of iron or steel. The first arched iron bridge was one over the Severn at Colebrooke Dale, erected by Abraham Darby in 1777; the arch-

ribs were in two pieces, each 70 feet in length and meeting at the keys, the clear span being 100 feet 6 inches, and the rise 45 feet; the ribs were solid, not tubular.

The aqueduct bridge over Rock Creek, at Washington (Fig. 6748), has a span of 200 feet between the abutments, with a rise of 20 feet. The arch consists of two ribs, each composed of 17 cast-iron pipes, with flanged ends, which abut and are firmly united by screw-bolts; the joints are water-tight, without packing or cement, under a head of 120 feet water. The two series of pipes are strongly connected together by diagonal ties and tubular cross-braces, and support a framework of heavy rolled-

Fig. 6748.

*Tubular-Arch Bridge over Rock Creek, D. C.*

iron H-beams, carrying two continuous horizontal iron girders, upon which rest cross-beams of timber, on which the roadway of the bridge is laid. All the water for the supply of the city of Washington passes through these pipes, which, to guard against freezing, are lined with staves and pitch-pine, leaving a clear water-way in each of 3 feet 6 inches. A water-pressure engine is located in a vault in the western abutment, capable of pumping 10,000 gallons of water per hour into the reservoir on Georgetown Hights, 204 feet above, supplying that part of the town which is above the level of the distributing reservoir.

Fig. 6749.

*Illinois and St. Louis Bridge (Center Arch).*

Tho Illinois and St. Louis Bridge, shown in Plate LXXI., and one span of which is shown in Fig. 6749, has three spans, each formed with four ribbed arches made of cast-steel. The center span has a length of 515 feet, the rise being one tenth the span; the two end spans are each 497 feet in the clear, and have a rise of 47 feet 10 inches.

The four arches forming each span each consist of an upper and lower curved member or rib extending from pier to pier, each being composed of two parallel steel tubes 9 inches in exterior diameter, placed side by side. The upper and lower members are 8 feet apart from center to center, and are held apart by cast-steel braces secured to cast-steel plates, formed somewhat like the voussoirs of a stone arch, against which the ends of the tube sections, 9 feet in length, abut. Horizontal and diagonal braces give lateral support, and serve to secure the upper and lower parts together. The car-tracks are below the level of the crowns of the arches, and are supported by them. The roadways are formed by transverse iron beams, supported by iron struts of cruciform section resting on the arches at the points where the vertical bracing of the latter is secured. The upper roadway is 34 feet wide between the foot-walks, which are each 8 feet wide, making the bridge 50 feet between the railings. The railway passages beneath the carriage-way are each 13 feet 6 inches wide and 18 feet high, extending through arched openings in the piers and abutments. The railways are carried over the wharves on each side of the river upon stone arches, and are inclosed by a cut stone arcade supporting the roadway. The railway at the St. Louis end passes immediately into a tunnel 4,800 feet in length, and at the Illinois end is continued on an easy down grade for 3,000 feet.

Tubular arches are also shown in some of the illustrations under IRON BRIDGE; TRUSS-BRIDGE. Arched beams not tubular are shown under ARCHED BEAM-ROOF; ROOF.

The piers of the bridge are founded upon the solid rock beneath the bed of the river, which is covered by sand to a depth of 78 feet at the eastern, and 50 feet at the western pier, the depth of water being in each case about 20 feet. The sinking of the piers was accomplished by the *plenum pneumatic* process; that is, by means of a caisson from which the water is expelled by a pressure of air sufficient to overcome the hydrostatic pressure. See PNEUMATIC CAISSON; CAISSON; AIR-LOCK.

**Tub'u-lar Boil'er.** (*Steam.*) A name properly applicable to a steam-boiler in which the water circulates in pipes, vertical, horizontal, or inclined, the fire encircling them. See TUBULAR STEAM-BOILER; TUBULOUS BOILER.

When the fire passes *through* the tubes, they are properly *flues*. The term is, however, applied to pipes, whether *water*-tubes or *fire*-tubes, below a certain diameter; the term *flues* belonging to those of a relatively larger diameter. See STEAM-BOILER, Plate LXI., in which are numerous illustrations of each kind; also LOCOMOTIVE, page 1346; and other places noted in the list under STEAM-ENGINE.

**Tub'u-lar Bridge.** A bridge formed by a great tube or hollow beam, through the center of which a roadway or railway passes.

A similar principle — that of the truss-beam — had been applied, varying, of course, in details of construction, to timber bridges, both in Switzerland and America; but the idea of the wrought-iron tubular bridge, and the carrying out of the details of construction which made it a success, are due to Fairbairn, to whom is due the credit of devising the form and proportions of the tubular bridges of Conway and Menai. The rectangular cellular beam laid on its edge and constructed of wrought and cast iron in their respective places was Fairbairn's, as was also the idea of making it self-supporting. Stephenson very reluctantly gave up the idea of supporting it by chains.

The most remarkable one ever constructed is that across the Menai Straits, on the Chester and Holyhead line of railway, and which unites the island of Anglesea with the mainland of Wales.

Plate LXXII. is a general view of the Britannia Bridge from the Caernarvon side, showing also the Menai suspension-bridge. A mile distant from it is the famous Telford suspension-bridge, built in 1829 by that prince of road-makers. Telford died in 1834.

Several requirements were made in regard to the tubular bridge to be erected over the strait.

Trains of all kinds were to cross it at full speed.

The Lords of the Admiralty stipulated that it should not be less than 105 feet above high-water level.

And that neither scaffolding nor centering should be used, as they would temporarily impede navigation at all points.

Stephenson, at first, designed a cast-iron bridge of two arches, in which the necessity for centering was obviated by connecting together the half-arches on each side of the center pier, on the principle suggested by Brunel. The two half-arches would thereby counterbalance each other, and be prolonged until they met their counterparts, which would spring from the abutments on each side of the straits.

This plan was rejected by the Admiralty, as it gave the specified hight at the *crowns* only of the arches.

The idea of the *beam* was then conceived, and the question arose how to build it. The round, or elliptical, form naturally presented itself, and, after the spans were determined, the three towers were commenced, and an expert board was appointed to determine the shape and structure. The board consisted of Messrs. Fairbairn, Hodgkinson, and Clark.

The points determined were, —

The tube must resist compression on its upper portion and extension on its lower portion.

The material should be principally accumulated above and below, and the middle should be hollow, whether it was of iron or wood.

Several evident reasons indicated iron as the material, and it was eventually determined to run the trains *through* the hollow iron beam instead of *upon* it.

Experiments determined that, while a cylindrical tube, with a given weight, was rent asunder beneath, and an elliptical tube was crushed at the top, a rectangular tube was more rigid than either

Then followed the discovery that, instead of riveting together

ILLINOIS AND ST. LOUIS BRIDGE ACROSS THE MISSISSIPPI RIVER.

PLATE LXXI.

CAPTAIN JAMES B. EADS, ENGINEER.

*See page* 2646.

BRITANNIA TUBULAR BRIDGE ACROSS THE MENAI STRAITS, VIEWED FROM THE CAERNARVON SIDE.

PLATE LXXII. TELFORD'S SUSPENSION BRIDGE AND THE MARQUIS OF ANGLESEA'S COLUMN IN THE DISTANCE. *See page* 2646

layers of plates, the same amount of material in a cellular form would give greater strength; so the layers were divided, and the spaces between them subdivided, by upright plates, into cells extending throughout the top and bottom of the tube.

The plate-iron sides and angle-irons formed ribs and skin to the double spine.

Chains for assistant support were contemplated, but eventually discarded. The tube was calculated to bear a distributed weight of 4,000 tons (2,240 pounds each), or 2,000 tons in the center; being 9 times the calculated load it would have to bear.

The piers are 3 in number, and the land abutments 2; the tubes 4, in appearance (or rather they appear continuous), but they were made in pairs, one for *up trains*, the other for *down trains*, so that there are actually 8 tubes, forming parallel bridges of 4 tubes each. The tubes next to the shore, on each side, were built upon scaffolding, and are each 230 feet long. The two spans in the middle of the strait are each 472 feet in length, and rest upon 3 towers or piers; the outer ones have each a base of 55 feet × 32 feet, and are 198 feet high. Each contains 210 tons of cast-iron beams and girders.

The central, or "Britannia," pier is 460 feet distant from its fellows, and is founded upon a rock. It is 230 feet high, and has a base 62 × 52 feet. It weighs 20,000 tons (English). Its exterior has 148,625 cubic feet of granite, filled in with 144,625 cubic feet of sandstone. 387 tons of cast-iron beams, or girders, are worked into it.

The tubes are composed of wrought-iron plates, from ⅜ to ¾ of an inch thick, the largest being about 12 feet in length, strongly united by rivets, and stiffened by angle-irons, and vary in exterior hight, which is 30 feet at the center of the bridge, diminishing to 22 feet 9 inches at the abutments. Their exterior width is 14 feet 8 inches, or 13 feet 8 inches in the clear, inside.

The tubes were built upon platforms on the Caernarvon shore, and floated on pontons into spaces between the piers. One side of a tube was floated into a vertical recess in one side of the tower formed for its reception, and then the other was floated down into a similar recess in the other tower, a portion of the lower masonry being omitted to allow it to pass in. These vertical recesses in the sides of the tower formed guides for the ends of the tubes while being raised to their elevated position. 800 men were employed in the removal of a tube, which was deposited on ledges of masonry on the piers.

The raising of each tube was separately performed by means of powerful hydraulic presses. The larger press had a cylinder 11 inches thick, the piston 20 inches in diameter, and a lift of 6 feet. The cylinder weighed 16 tons, the machine 40 tons (English, 2,240 pounds). See Fig 2627, page 1156.

Two smaller presses had rams 18 inches in diameter, and acted at one of the tubes, while the larger one operated at the other end. They stood on the piers, and lifted by chains. The chains and lifting-frames added 400 tons to the weight to be lifted.

The power was derived from 2 steam-engines of 40 horse-power each, delivering water through a ½-inch pipe into the cylinder below the ram. As the tube rose it was secured beneath. It was raised by successive lifts of 6 feet each, each occupying 30 minutes. The ends rest on rollers so as to allow the tube to expand and contract without grinding the coping of the pier.

The bridge contains 9,480 tons of wrought-iron, 1,988 tons of cast-iron, and 1,500,000 cubic feet of masonry. Its cost was about $3,000,000. It was first crossed by a railway train, March 1, 1850.

Some other data are given under BRIDGE (which see).

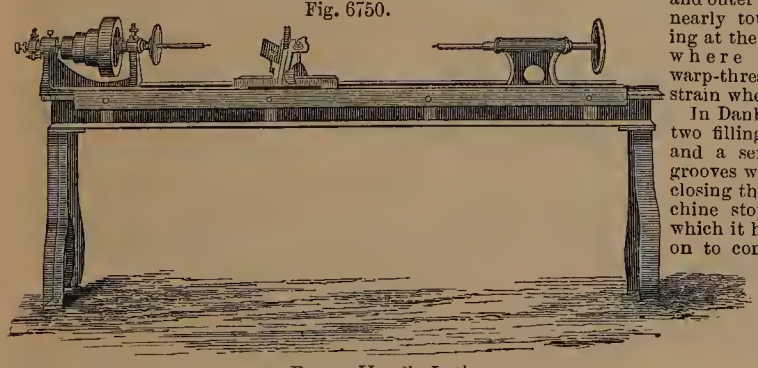
The Victoria tubular bridge at Montreal, forming a part of the Grand Trunk Railway of Canada, was designed by Stephenson, and built under his direction by James Hodges of Montreal. It was completed in December, 1859, and opened for travel August 25, 1860.

The total length of this immense structure is only 176 feet less than two miles; it is supported upon two abutments and 24 piers, having 25 spans of tubing, the center one of which is 330, and each of the others 242 feet long. The hight of the central tube is 60 feet above the summer level of the water. The bridge has a slight descent from the center toward each end. The two center piers are 24 feet wide, the others being 16 feet, and each presents a wedge-shaped cutwater up stream to break the ice, which on the St. Lawrence frequently attains a thickness of 3 to 5 feet, often becoming piled to the hight of 50 feet or more on breaking up in the spring. The tubing of this bridge differs principally from that of the Britannia Bridge, before described, in not being cellular at top and bottom. Each plate and piece of iron was punched in England before being sent to Canada, so that little, except putting them together and placing them in position, remained to be done on the spot. This, however, was a work of great labor, requiring the erection of a rigid timber stage or trussing supported by massive temporary piers of wood, on which the tubes were built up plate by plate. These trusses were removed when the work was completed, leaving the tubes resting at each end on the piers and abutments alone. Expansion and contraction are provided for by rollers underneath the end of each span. The total cost was £1,250,000. The first stone of this bridge was laid July 22, 1854; and on December 17, 1859, the first train passed over.

**Tub'u-lar Crane.** A crane whose hollow jib is made of riveted boiler-plate. See CRANE; STEAM-CRANE; TRAVELING-CRANE.

**Tub'u-lar Cut'ter.** Fig. 6750 illustrates a lathe for turning broom-handles or similar objects. The sliding head has a tubular cutter, which passes along and rounds the stick; it acts as cutter and guide, the piece being too thin and pliable to work well unless supported on the side opposite to the tool.

Fig. 6750.

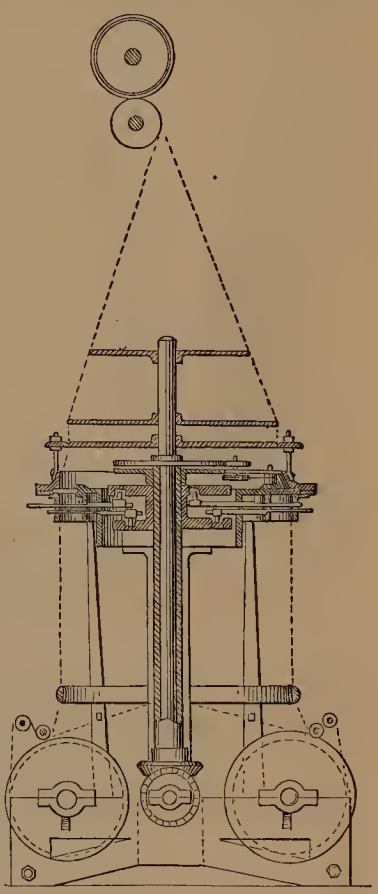


*Broom-Handle Lathe.*

**Tub'u-lar Fab'ric-loom.** (*Weaving.*) A machine for weaving hollow goods, such as bags, skirts, and other tubular fabrics.

In Greenough's circular loom, the sole of the shuttle-race is formed by the reed; the shuttle has a roller at its heel, by which it receives its impulse from a revolving arm having a positively revolving roller at its end; a projecting wedge-shaped fin on the shuttle, having rollers thereon, causes the forcing or beating up of the weft-threads in the shed. An inner and outer ring nearly touching at the line where the warp-threads cross each other, relieve the warp from strain when the shuttle is beating up.

Fig. 6751.



*Greenough's Circular Loom.*

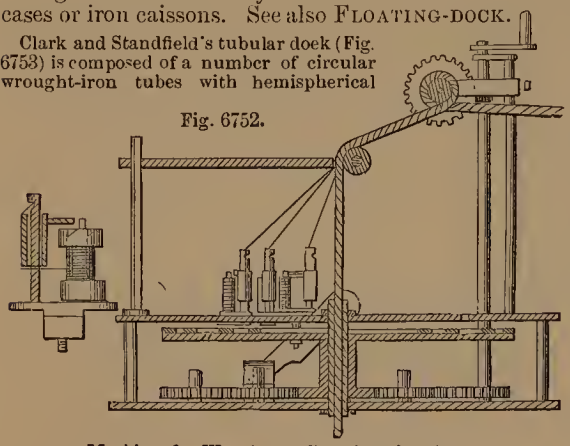
In Danby's machine for weaving a covering for cords, two filling-thread carriers travel in a circular groove, and a series of weft-thread carriers travel in radial grooves which cross the circular one, thus opening and closing the shed. When a weft-thread breaks, the machine stops automatically, thus: the weight or slide which it has held up drops, allowing a projection thereon to come in contact with an arm and unlatch the weighted lever, whose upper arm in rising lifts the cog-wheel out of gear with the driving-gear.

**Tub'u-lar Float'ing-dock.** One whose flotative power depends upon

air-tight chambers or cylinders. These are wooden cases or iron caissons. See also FLOATING-DOCK.

Clark and Standfield's tubular dock (Fig. 6753) is composed of a number of circular wrought-iron tubes with hemispherical

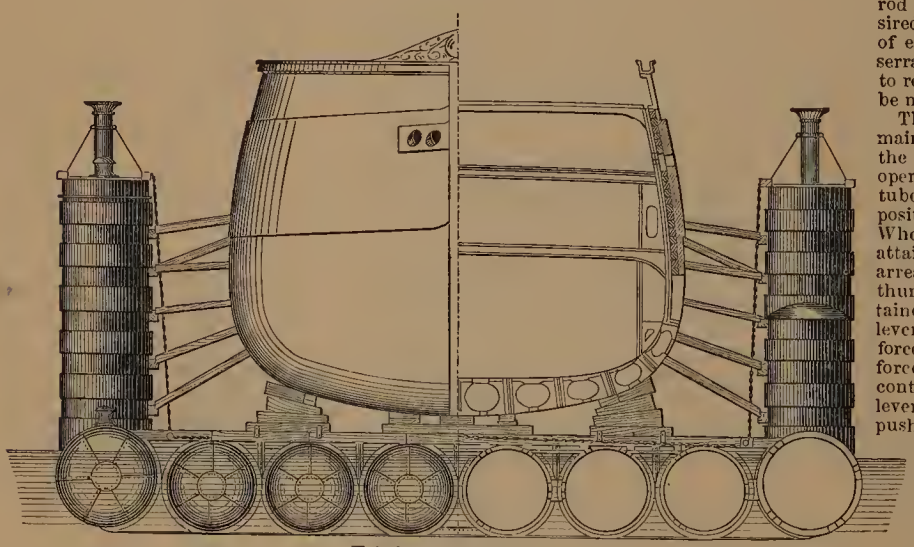
Fig. 6752.



*Machine for Weaving a Covering for Cords.*

ends, stiffened inside by angle-irons at intervals of two or three feet, and securely braced together by T and angle irons above and below, forming transverse girders of sufficient strength to support the weight of a vessel. These tubes are usually eight in number, and form a platform having sufficient buoyancy to float the superstructure and a ship. The two outer tubes are

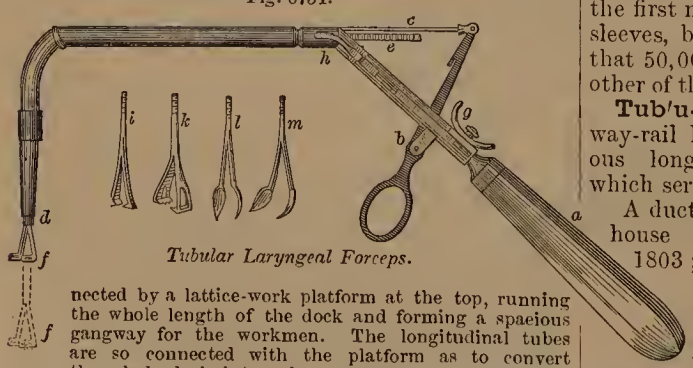
Fig. 6753.



*Tubular Floating-Dock.*

of larger diameter than the interior ones, and the central tubes are longer than those at the sides, so that the structure is somewhat pointed at the ends. The sides of the dock are each formed of from 12 to 24 similar vertical tubes, braced together and con-

Fig. 6754.




*Tubular Laryngeal Forceps.*

nected by a lattice-work platform at the top, running the whole length of the dock and forming a spacious gangway for the workmen. The longitudinal tubes are so connected with the platform as to convert the whole dock into a beam or girder of great depth and rigidity. The tubes are divided within into water-tight compartments connected by pipes. The base of the dock contains about sixty and the sides about forty of these compartments, those of the sides being hermetically closed, so that the dock cannot sink. A certain number of the bottom compartments are also hermetically closed, and the remainder are provided with valves at bottom, which can be opened and closed at pleasure, and with wrought-iron pipes which are grouped together, and all carried to a valve-house on the upper platform, where they are under the control of the valve-engineer. When it is desired to sink the dock, the bottom valves are opened and the air allowed to escape at the valve-house until the dock settles down to the required level. When it is desired to raise it, compressed air is forced into the tubes, expelling the water through the bottom valves, which are closed when the dock and the vessel upon it are raised to the proper hight.

The engines are in two pairs, placed within the vertical tubes near the center of the dock. The whole of the water-tight compartments in the bottom are divided into four equal groups corresponding to the four corners of the dock, and by means of four corresponding valves in the valve-house air is forced into or withdrawn from either or all of these four groups, so that the dock may be kept perfectly level in raising or lowering.

**Tub'u-lar For'ceps.** (*Surgical.*) The tubular laryngeal forceps (Fig. 6754) is designed for the extraction of tumors in the larynx.

It consists of a bent tube 7 inches long, and having a handle *a*, making with it an angle of 45°. On the handle is a lever *b* connected with a rod *c*, which passes through the tube and has attached at its lower extremity a smaller tube *d* within the larger one, by which the vertical portion of the instrument is lengthened and the forceps closed at will. Beneath *c* is another rod *e*, serrated at its upper extremity, which also passes through the tube and terminates in a socket, into which the forceps *f* is screwed. A slide on the handle, operated by the thumb-piece *g*, is so connected to two small retaining-levers *h*, that pressure on the thumb-piece causes the retainers to grasp the serrated rod *e* and retain it in any desired position. The outer side of each limb of the forceps is serrated, to enable the tube *d* to retain its hold, though there be no pressure on the lever *b*.

The vertical portion of the main tube is introduced into the larynx, and the lever *b* operated, projecting the smaller tube and the forceps into the position shown in dotted lines. When the proper position is attained, the serrated rod is arrested by pressure on the thumb piece, causing the retainers to grasp the serrated lever, retaining it and the forceps in that position. The forceps are then closed by continuing the pressure on the lever, causing the rod *c* to push the smaller tube over the base of the forceps and close them. Various forms of forceps, as *i k l m*, may be used.

**Tub'u-lar Gird'er.** A hollow girder made of any shape of plates secured together. (See IRON BRIDGE.) The tubular bridge is but the largest kind of tubular girder.

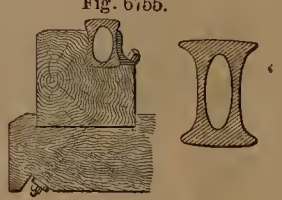
**Tub'u-lar Goods Sew'ing-ma-chine'.** The Akins and Felthousen patent of August 5, 1851, was the first machine to sew tubular goods, such as shirt-sleeves, boot-legs, etc.; and in 1865 it was estimated that 50,000 sewing-machines, embracing one or the other of the features of this improvement, were in use.

**Tub'u-lar Rail.** A railway-rail having a continuous longitudinal opening which serves as

A duct for water; Woodhouse English patent, 1803; or

A steam-pipe to prevent the accretion of ice or snow upon the track; Grimes's English patent, 1831.

Fig. 6755.



*Tubular Rail.*

Montgomery's tubular rail has its upper and lower faces alike so that it may be reversed when injured by wear. It is held on one side by a rabbet in the longitudinal sill upon which it is laid, and on the other by locking plates secured by bolts pass-

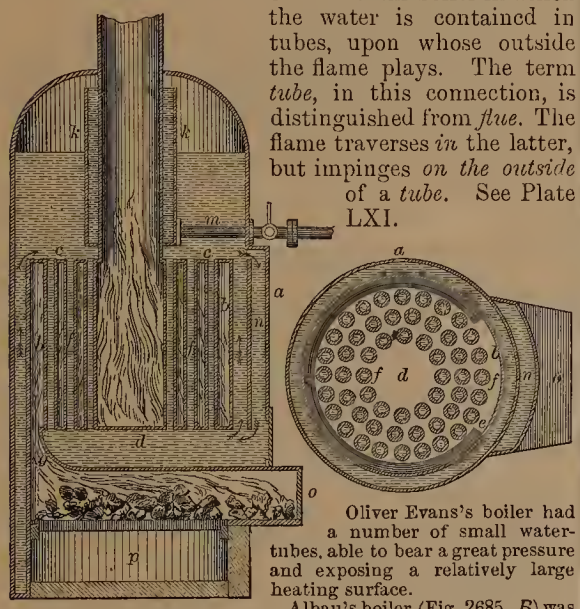
ing through the sills and ties. A uumber of other forms might be mentioned.

**Tub'u-lar Rein.** One in whieh an additional or safety rein slips through the other rein, which is hollow. See the following patents: —

13,306. Goddard, July 24, '55. | 61,512. Donehoo, Jan. 29, '67.
59,596. Hartman, Nov. 13, '66. | 65,721. Brook, June 11, '67.

**Tub'u-lar Steam-boil'er.** A steam-boiler in which the water is containcd in tubes, upon whose outside the flame plays. The term *tube*, in this connection, is distinguished from *flue*. The flame traverses *in* the latter, but impinges *on the outside* of a *tube*. See Plate LXI.

Fig. 6756.



*Napier's Tubular Boiler.*

Oliver Evans's boiler had a number of small water-tubes, able to bear a great pressure and exposing a relatively large heating surface.

Albau's boiler (Fig. 2685, *B*) was on the same principle, with the additional idea of dropping into the vertical tubes small charges of water which instantaneously flashed into steam. See also Fig. 5629, Plate LXI., and INSTANTANEOUS GENERATOR, page 1190.

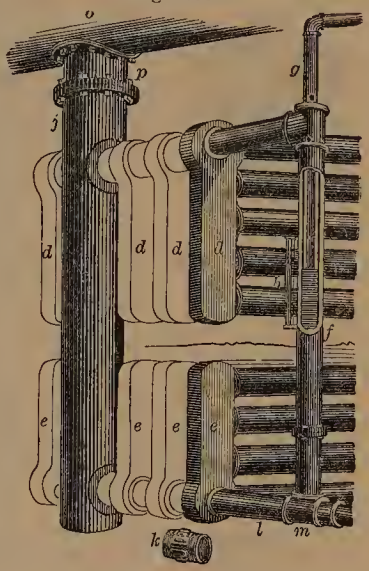
Booth and Stephenson's locomotive "Rocket" had 25 copper *flue*-tubes, 3 inches in diameter, open at one end to the chimney and to the fire-box at the other.

As many as 303 flue-tubes are employed in the "Great Western" engine, England. See also STEAM-BOILER, Plate LXI.

In tubular marine boilers, the flame and hot gases from the furnaces are led through a great number of small *flue-tubes* (of iron or brass), completely surrounded by water to the *uptake* at the bottom of the chimney.

Fig. 6756 shows Napier's tubular marine boiler. *a a* is a cylindrical chamber with a dome top, or outer casing of the boiler; and *b b* is a smaller cylinder with a flat top *c*, placed within the chamber *a*, and constituting the fire-box, while the space included between the two cylinders forms the water-chamber. Within the fire-box, and on a level with the upper part of the fire-door, is a flat circular vessel *d*, which is connected to the annular part of the water-chamber by a neck *e*, and to the upper part of the chamber by several concentric rows of tubes *f f*. This vessel *d* is somewhat less in diameter than the fire-box, so that there is an annular space *g* between its circumference and that of the fire-box, which forms a flue or passage for the smoke and heated gases from the furnace. The caloric current then traverses between the *flue-pipes f f*, and escapes by the chimney, which rises from the roof of the fire-box and passes out through the dome of the boiler. To protect the chimney from the effects of the fire, that portion within the boiler is surrounded by a water-casing *k*, which is open at top. The feed-water enters near the bottom of the casing by the feed-pipe *m*, and overflows at the top.

Fig. 6758.



*Section of "Anderson" Tubulous Boiler.*

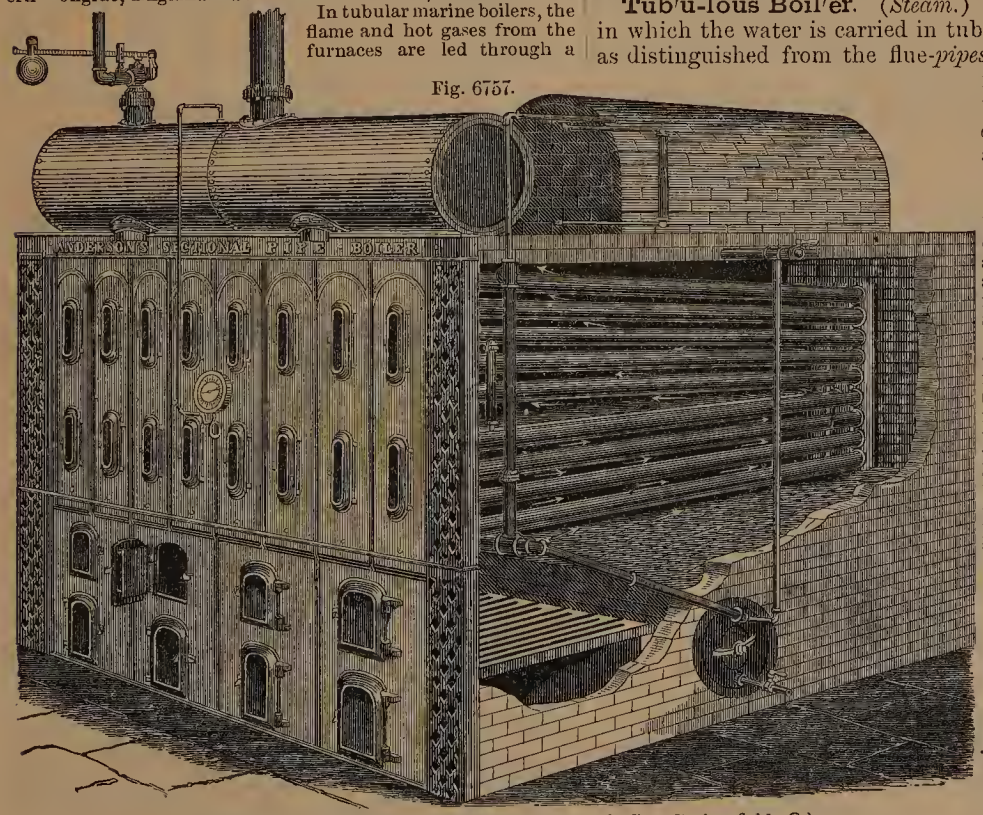
In order to establish a circulation of water in the boiler, a wide channel *n* is formed on the outside of the casing, which, being farther removed from the fire-box than any portion of the annular chamber, a descending current is maintained therein, while an ascending current is established in the annular water-chamber and pipes.

*o* is the fire-door; *p*, the ash-pit.

**Tub'u-lat'ed Re-tort'.** One with an opening at top, closed by a stopper.

**Tub'u-lous Boil'er.** (*Steam.*) A form of boiler in which the water is carried in tubes or *water-pipes*, as distinguished from the flue-*pipes*, through which flame passes, as in the *flue-boilers* of locomotives and elsewhere. A *tubular* boiler.

Fig. 6757.




*The "Anderson" Tubulous Boiler (Mast, Foos, & Co., Springfield, O.)*

Fig. 6757 shows Mast's *tubulous* boiler, the name being a sort of protest against the confounding of *water-tubes* with *flue-pipes*.

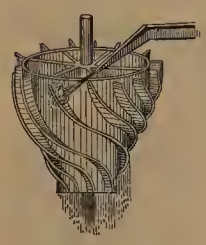
Each section is composed of two front manifolds *d e* (Fig. 6758) and one rear one, connected together by the upper and lower sets of tubes; these tubes being fitted to their places by right and left hand threads. These sections are united to each other by nipples *k* at the top and bottom of front manifolds, and the combination is completed by connecting the sets of sections to each side of a central column *j p*, to the top of which is attached the steam dome *o*. Extending outside of the masonry from

the upper and lower sections are two pipes *l* connecting to a vertical stand-pipe *f*, containing the automatic water-regulator. From the lower end of this stand-pipe extends another pipe to the mud-drum *m*, while from the top a pipe *g* connects to the feed-tank. The tubes are lap-welded, of wrought-iron. *b* is the gage-glass.

**Tu'bu-lure.** A tubular opening at the top of a retort.

**Tub-wheel.** A form of water-wheel which has a vertical axis and radial spiral floats, which are placed between two conical cases attached to the axis. The water is precipitated from a chute upon the wheel, and follows the spiral canals of the wheel until it is discharged at the bottom.

Fig. 6759.



*Tub-Wheel.*

It is a combination of the *horizontal* and common *recoil* wheel; the water, having exerted a certain percussive force, flows downward, and passes out like that in the *downward-discharge turbine.*

**Tuck.** 1. (*Shipbuilding.*) *a.* The after part of a ship, where the ends of the bottom planks are gathered, under the stem or counter. Its shape gives a name to the build, as *square*-tuck.

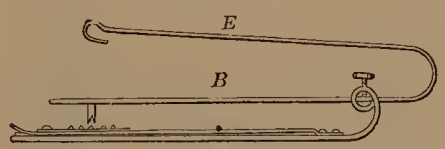
*b.* The square stem of a boat.

2. A horizontal fold or plait in a skirt, wide or narrow, and sewn throughout its length.

**Tuck-creas'er.** An instrument for making a crease upon cloth while passing through the machine, to afford a line of fold for the next tuck. Invented by Fuller.

The illustration is one of many kinds. As the needle-bar descends, it presses on the spring-bar *E*, which descends on *B*,

Fig. 6760.




*Tuck-Creaser.*

and presses the forked bar down upon the cloth and it upon the spurs beneath. See TUCK-MARKER. See also Fig. 4875, page 2121.

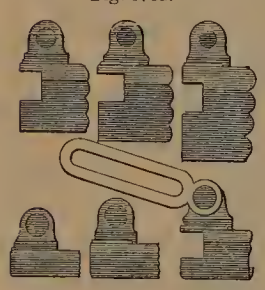
The early patents were Singer, 1856; Arnold, Wheeler, and Fuller, 1860.

**Tuck-fold'er.** For folding over a tuck in advance of sewing on the machine.

Goodrich's are made in sets; six in a set, adapted to various widths and spaces, and to various machines.

"They are confined to the machine by thumb-screws. After selecting the width of the folder required, fold the goods where you want the first tuck; then introduce the folded edge under the folder and up against the gage. Stitch the first tuck and press it flat, then make a fold in the goods just wide enough to fill the whole space in the folder when the tuck just made is placed in the front edge or hook portion, which serves the purpose of a guide to keep the tuck just made parallel to the next tuck. Keep the space between the two gage-lines full of cloth, and the tucks and spaces will be even."

Fig. 6761.



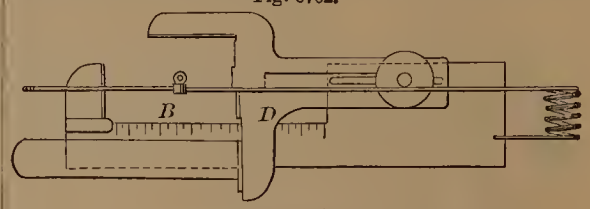
*Goodrich's Tuck-Folders.*

**Tuck'ing-gage.** (*Sewing-machine.*) An attachment for marking tucks at a determinate distance ready for the next line of sewing. See TUCK-MARKER; TUCK-CREASER.

**Tuck-mark'er.** A device, also known as a *tuck-creaser*, for making a crease on goods as a guide for width in making the next fold. The example has, besides the bar which is depressed by each descent of the needle, a gage for width of tuck. See also SEWING-MACHINE ATTACHMENTS, pages 2120, 2121.

In a later patent, the *creasing-plate B* has a scale marked from left to right, while the *gage-plate D* has a scale whose figures indicate spaces half as large as those of the *creasing-plate*, but

Fig. 6762.



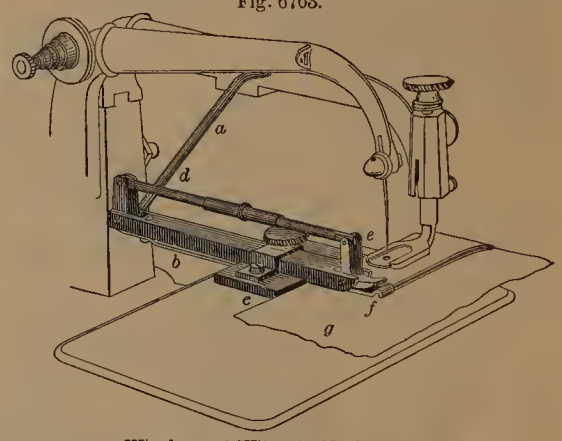

*Tuck-Marker.*

increasing in the reverse direction. The *gage-plate* is set with any figure at the point desired for a given width of tuck, and the *creasing-plate* is moved to a figure of double the value of the figure used on the gage, thus arranging the tucks in groups, the spaces between being twice the width of a tuck.

Jones's chart and scale for tuck-markers; patent dated August 11, 1874.

Fig. 6763 shows a tuck-marker as adapted to the old Wheeler and Wilson machine. Insert the loose end of the connection *d* into the tube of the same, and attach the marker to the cloth-

Fig. 6763.




*Wheeler and Wilson's Tuck-Marker.*

plate by means of the thumb-screw. Set the gage *c* far enough back from the needle to make the tuck the desired width, and fasten the thumb-screw and the creaser as far forward as you desire to fold the cloth for the next tuck, and fasten it by tightening the clamp-screw on the gage. Regulate the creaser *f* to make a good mark by means of the connection.

**Tuck-net.** (*Fishing.*) A landing net; one for dipping fish out of a larger net.

**Tue'fall.** (*Architecture.*) A building with a sloping roof on one side only.

**Tue-ir'on.** (*Forging.*) *a.* A *tuyere*, *tweer*, or blast nozzle of a forge or furnace. See TUYERE.

*b.* A blacksmith's tongs.

**Tu'fa.** A calcareous deposit which affords a hydraulic lime. *Trass*, *tarrass*, *travertine*, *pozzuolana*, are local names, and vary in quality to some extent.

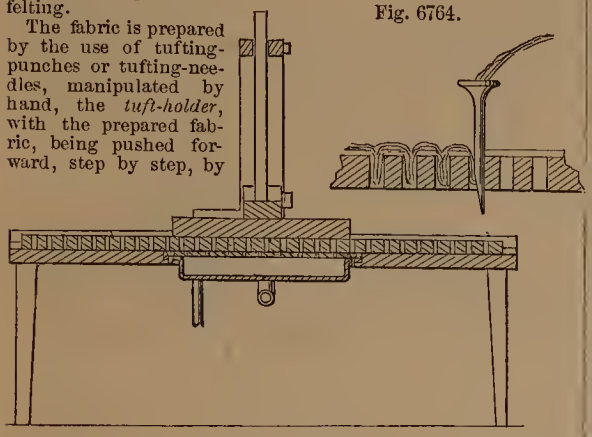
**Tuf-taf'fe-ta.** (*Fabric.*) Tufted taffeta; a shaggy or *rillous* silk fabric.

**Tuft'ed Fab'ric.** A fabric in which tufts are set, as in the old form of Turkish and Persian carpets, in which tufts were set in on the warp, and then locked in by the shooting of the weft and the crossing of the warps.

Fig. 6764 shows a mode of making tufted fabric on a felted backing. The tufts of yarn or rovings are introduced through the cloth by means of a suitable needle and a perforated board or *tuft-holder*. The object of the subsequent felting is to prevent the tufts from being pulled out of the fabric; hence either the back of the fabric, or the tufts, or both, must have sufficient

felting properties to unite with the bat or sliver, or with each other by the process of felting.

Fig. 6764.



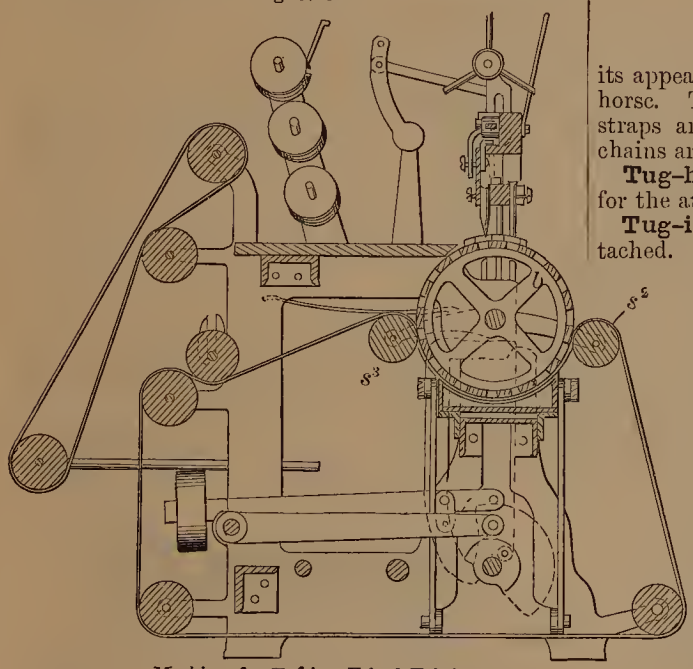
*Felted Tufted Fabric.*

The fabric is prepared by the use of tufting-punches or tufting-needles, manipulated by hand, the *tuft-holder*, with the prepared fabric, being pushed forward, step by step, by hand, to the *jigger-board* and *steam-table* where the *hardening* is effected.

### Tuft'ed-fab'ric Ma-chine'.

Fig. 6765 is Eickemeyer's machine for setting in the tufts and felting them into and hardening the body in a continuous operation, in imitation of a *terry* fabric, as velvet; or a larger pile to imitate plush, shaggy goods, or fur. The machine is supplied with material for the tufts, whether bats, yarns, or rovings, and material for the body of the fabric, whether bats or cloth, and from them prepares a continuous tufted felted fabric. The *bat* is received from a carding-machine. The tuft-holder is a hollow cylinder *b*, with holes on its periphery which receive the tufts when the gang of tuft-punches descend. To give a diagonal position to the tufts, so that each may be opposite to the vacancies in the previous row, the gang of punches have, besides their up-and-down motion to punch the bats into

Fig. 6765.




*Machine for Tufting Felted Fabrics.*

the holes, a side motion across the machine alternately in opposite directions, to correspond with the positions of the tuft-holes. The tuft-punches move the tuft-holder on its axis, step by step, one row at a time, while within the tuft-holes, then withdraw from the tuft-holes, and move back over the next row of tuft-holes to be filled. A presser-plate covers the holes just filled, and a plaiter punches the bat forward over the next row of holes to make the next row of tufts. A *jigger* or rubbing-plate, perforated with fine holes for steam, is applied to the under side of the tuft-holder when in action for felting, which takes place periodically as the tuft-punches are withdrawn, and lasts till they are about to again descend. The bat which forms the back of the fabric is received from a carding-machine on the feeding-apron, which extends over the drums $s^2$, $s^3$, etc., passing between the concave jiggering-surface of the steam-box and the tuft-holder, from the rear to the front of the machine; thence downward, and underneath the machine, to the rear.

This feeding-band is also a hardening cloth, and is made of linen or canvas. The fabric as it comes from the machine is wound on a roller.

**Tuft-mock'a-do.** (*Fabric.*) A mixed stuff of silk and woolen, in imitation of tufted taffeta or velvet.

**Tuft-taf'fe-ta.** Formerly, a fabric with silk tufts.

**Tug.** 1. (*Harness.*) A trace by which the draft animal pulls the load.

At the end of the trace is a tug-hook, or cock-eye; the former for a *but-chain*, the latter for attachment to the *tug-pin* on the end of the *single-tree*.

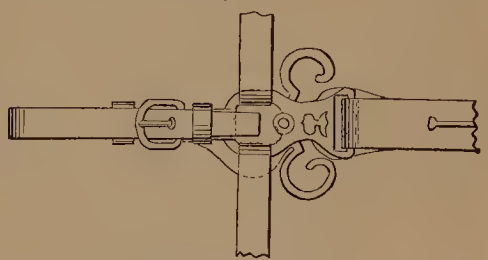
2. (*Nautical.*) A steam-vessel used for towing a sailing or disabled vessel, or a hull before receiving its rigging or steam equipment.

3. (*Mining.*) The iron hoop of a *corve* to which the tackle is attached.

4. (*Vehicle.*) A kind of timber carriage.

**Tug-car'ri-er.** (*Harness.*) An attachment to the back strap of wagon harness. The figure shows

Fig. 6766.



*Tug and Chain Carrier.*

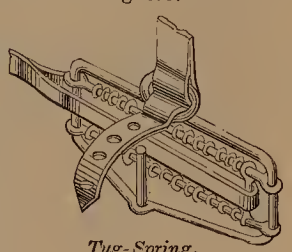
its appearance as viewed from above the back of the horse. The ring in the back strap to which the hip straps are attached has side hooks on which the chains are hung when unhitched.

**Tug-hook.** (*Harness.*) A hook on the hame for the attachment of the trace.

**Tug-ir'on.** The hook to which a trace is attached.

**Tug-slide.** (*Harness.*) A metallic frame in which the tug is adjusted as to length. It is a substitute for a buckle.

Fig. 6767.



*Tug-Spring.*

**Tug-spring.** (*Harness.*) A frame with spring suspended from the back and having points of attachment for the tug and hold-back straps to prevent too great a jerk on the animal in starting and stopping.

**Tu'la-met'al.** An alloy of gold, silver, and lead.

**Tulle.** (*Fabric.*) A thin silk lace with open meshes, woven in narrow strips.

**Tum'bler.** 1. (*Founding.*) A vertically rotating case for cleaning castings placed within it.

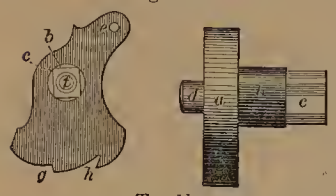
2. (*Locksmithing.*) A latch engaging within a notch in a lock bolt, or otherwise opposing its motion until it is lifted or arranged by the key, so as to remove the obstacle. See Lock.

3. (*Fire-arms.*) The piece in the interior of a

gun-lock by which the main-spring acts on the hammer, causing it to fall and explode the cap.

It is connected with the main-spring by a *swivel*, which transmits the full pressure of the spring to the swivel arm. The tumbler has a partial revolution on pivots (the *arbor* being one), the extreme limits of its motion being from full cock to the striking of the hammer on the cap.

Fig. 6768.

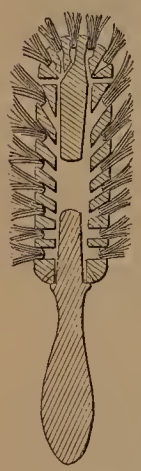



*Tumbler.*

*a, body; b, arbor; c, square; d, pivot; e, swivel-arm and pin-hole; f, tumbler-screw hole; g, cock-notch; h, half-cock notch.*

The hammer is carried on the *square* of the tumbler: this is the outwardly projecting end of the arbor. It operates as follows: when the hammer is drawn back, the tumbler rotates in the direction *g h*; the *sear*, which is kept constantly pressed against the tumbler by the sear-spring, falls, first, into the notch *h*, and by a farther rotation into the cock-notch *g*; here it is held by the spring until a pressure on the trigger releases the nose of the sear from the notch and permits the tumbler to follow the movement of rotation impressed on it by the main-spring, which it does with great rapidity.

Fig. 6769.



*Tumbler-Brush.*

4. (*Nautical.*) One of the movable pins with which the *cathead-stopper* and *shank-painter* are respectively engaged. By the coincident movement of the pins, the ends of the anchor, which are suspended from the *cathead* and *fish-davit* respectively, are simultaneously freed.

5. (*Domestic.*) A drinking-glass with a flat base, no stem, and straight, somewhat flaring sides. It originally had a round or pointed base, so that it could not stand alone, and one must empty it before putting it down.

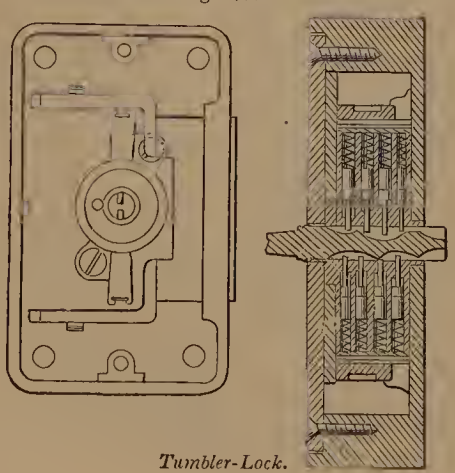
6. (*Vehicle.*) A kind of cart. A *tumbrel*.

**Tum'bler-brush.** The cylindrical block is axially perforated, and the holes for the bristles lead at an incline into the central bore. The handle and cap-piece are secured to the block by their cylindrical ends entering the bore of the block.

**Tum'bler-lock.** A lock which has latches or disks which require to be arranged in specific relation to enable the bolt to be shot. See LOCK; PERMUTATION-LOCK; and others cited in the list under LOCK, page 1342.

In the figure, the bolt is actuated by an eccentric which is connected to a cylinder having a keyhole into which the tumbler-keys project; these slide radially in the cylinder and abut on similarly sized spring pins in the hub. The key is of proper form to adjust the tumbler-pins, so that their ends shall coincide with the periphery of the cylinder and allow its rotation in the hub.

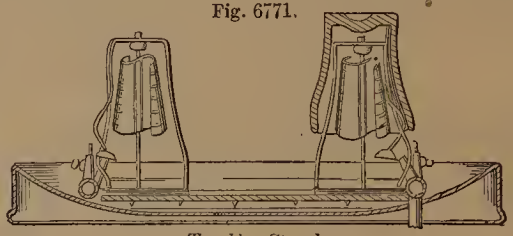
Fig. 6770.



*Tumbler-Lock.*

**Tum'bler-punch.** (*Fire-arms.*) A small two-bladed punch used for pushing the arbor of the tumbler, the band-springs, etc., from their seats, in taking a gun apart.

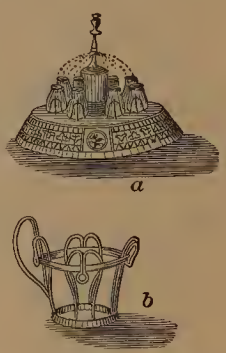
Fig. 6771.



*Tumbler-Stand.*

**Tum'bler-stand.** A tray with tripods, to hold tumblers reversed over a jet which washes them. The illustration shows one frame empty and one with the tumbler in position.

Fig. 6772.




*Tumbler Washer and Holder.*

**Tum'bler-wash'er.** A device (*a*) used in connection with soda-fountains or in bar-rooms, to wash tumblers. As shown, it has a jet for the inside of each tumbler and a sprinkler for the outsides.

*b* is a tumbler-holder, to avoid soiling the gloves in drinking soda-water or beer.

**Tum'bling-bay.** (*Hydraulics.*) A *weir* or overflow-dam.

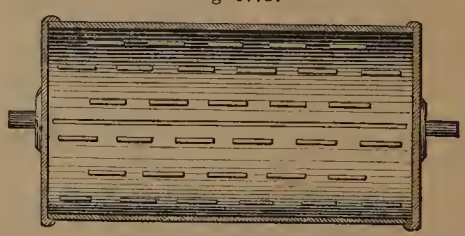
**Tum'bling-bob.** A counterpoise weight on an arm to cause it to react by gravity when the lifting lever is withdrawn.

**Tum'bling-box.** A contrivance for cleaning castings, and grinding or polishing small articles by attrition. It consists of a cylindrical or barrel-shaped vessel having a side door for the introduction of the work, and is mounted on an axis so as to be revolved by a winch or pulley. Called also *rumble*, *rolling barrel*. It is sometimes arranged to be shaken endways by means of a crank, and is then termed a *shaking*-machine.

Its uses are numerous: as, for cleansing small castings; brightening iron tacks previous to tinning; polishing steel-pens, needles, and pins, bone buttons, lead shot, rusty cannon-balls, etc.; and for dissolving gums in spirits of wine for making lacquers and varnishes.

Some material is put in with the articles — slag, cinders, sand, or emery — when grinding is the object; graphite with or without scraps of leather when the articles are to be polished.

Fig. 6773.



*Founders' Cleansing-Mill.*

The use of the tumbling-box is increasing; the tines of hay-forks, until late polished by an emery belt, are now finished in large cast-iron tumblers.

In Fig. 6773, the barrel is formed of perforated metallic staves secured between two flanged heads, and overlapping each other at the joints.

**Tum'bling-home.** (*Shipbuilding.*) Said of the sides of a vessel when they lean in. When vertical,

they are said to be *wall-sided ;* when they lean out, *flaring.*

**Tum'bling-shaft.** (*Machinery.*) A cam-shaft ; employed in stamping-mills, thrashing-machines, etc.

**Tum'brel.** A contrivance, formerly used for ducking scolding women, otherwise known as a ducking-stool for refractory shrews. *Tempora mutantur, et nos mutamur in illis.*

It was a chair attached to a long pole; the vixen was tied in the chair, swung over the pond, and immersed till she was supposed to be (temporarily) cured.

**Tum'bril.** 1. (*Ordnance.*) A covered cart for containing ammunition and tools for mining and sapping.

2. (*Vehicle.*) A manure-cart.

3. (*Husbandry.*) A large willow cage or rack for sheep feed.

**Tum'mals.** (*Mining.*) A great quantity. A heap.

**Tum'pline.** A head strap by which a porter steadies a pack carried on the shoulders and back.

**Tun.** The fermenting vat of a brewery.

**Tun'bridge-ware.** A kind of small cabinet work in which thin veneers of fancy woods are cut into small pieces, and glued upon a foundation, forming a mosaic, generally of geometrical figures.

**Tung'sten.** Equivalent, 94 ; symbol, W.; specific gravity, 17.6 ; fusible under the blow-pipe. A hard, brittle, white metal. Tungstate of lead is used as a pigment. See METALS.

**Tun'ing-fork.** (*Music.*) *a.* A pronged piece of steel adjusted to emit a particular tone when struck.

The pitch varies with the length, width, and thickness of the prongs, and may be made to correspond with any note of the gamut. In practice, that giving the sound of the middle or tenor C is employed ; this is usually assumed to correspond to 512 single vibrations per second, but modern custom has adopted a higher pitch. In France 522, and in England and Germany 528, vibrations per second are taken as the standard for C. See PITCH ; TELEPHONE ; PIPE ; etc.

*b.* An instrument for turning the pins and tightening the wires of piano-fortes.

**Tun'ing-ham'mer.** A tuning instrument having two heads on the handle, and so resembling a hammer.

**Tun'ing-key.** A kind of wrench employed for imparting the proper tension to the strings of piano-fortes, etc.

In Sherwood's (Fig. 6774), the socket *a* is adapted for being placed over the pin of a string to be tuned while the fork *b* is placed over the adjacent pin. The wrench *c* is first applied to the stem *d*, and turned until the string is brought nearly to the proper pitch ; the arm *e*, which carries a worm, is then thrown

Fig. 6774.

*Tuning-Key.*

into gear with the worm-wheel *f* at the extremity of the stem *g*, and the wrench *c* is fitted to this arm, enabling a gradual but very powerful tension to be applied to the string.

**Tun'ing-pin.** (*Music.*) A pin around one end of which the string or wire is wound, and by turning which it is tuned.

**Tun'nel.** 1. (*Engineering.*) A horizontal or slightly inclined gallery beneath the surface of the ground ; generally used for an aqueduct or for the passage of a roadway or canal.

Very extensive works of this kind were executed by the ancients ; especially by the Romans, as a part of their magnificent structures for supplying cities with water.

One tunnel of antiquity is spoken of by Herodotus with great praise. He describes it as executed by Eupalinus, son of Naustrophus, a Megarian, for the city of Samos, on the island of the same name. "A tunnel under a hill 150 fathoms high, carried entirely through the base of the hill, with a mouth at either end. The length of the cutting is 7 furlongs ; the hight and width are each 8 feet. Along the whole course there is a second cutting 20 cubits deep and 3 feet broad, whereby water is brought through pipes from an abundant source into the city." — Book III. chap. 60.

Strabo mentions a tunnel at Cumæ connecting that town with Avernus, made by Cocceius during the Augustan age. A more ancient and longer one had been made long previously between Dicæarchia (Puteoli) and Neapolis (Naples). It is yet open, and is known as the Grotta di Pausilipo. It is referred to by Seneca.

The lakes Trasimene, Albano, Nemi, and Fucino in Italy were all drained by tunnels (*emissaria*) ; the last mentioned was devised by Julius Cæsar and executed by Claudius A. D. 52. It is still nearly perfect. The circumference of the lake drained was 30 miles. The length of this tunnel is about 3 miles, discharging into the river Liris (Garigliano). 30,000 men were employed ; time occupied, 11 years. A large number of shafts were sunk to allow a greater number of men to work and to facilitate the removal of detritus. It is from 20 to 30 feet high and 28 to 30 feet wide.

That which drained the waters of Lake Albano was cut through lava, about 6 feet high, 3½ feet broad, and 6,000 feet long. 50 shafts were sunk, and the work was prosecuted at many points, being completed in one year, 398 B. C. A water tower was erected at each end, and these, together with the arched conduit, are in good condition yet.

The stone mountain of Gibraltar is tunneled into galleries, from whose embrasures peep the grim cannon which defend the bay and the neutral ground. Quite a change since Gibraltar, *Gebel el Tarik*, Tarik's Mountain, was the scene of the landing of this lieutenant of the Emir Musa, April, A. D. 711. Musa the Saracen conquered Spain. The galleries in the rock are nearly 3 miles long, large enough to admit a carriage, and are pierced for cannon at every 12 yards. One thousand cannon are thus mounted.

A tunnel under the Thames, to connect Gravesend with the Essex side, was projected by Ralph Dodd, Esq., in 1798. In 1804, Mr. Chapman proposed to tunnel below the river from Rotherhithe to the north bank. In 1807 the work was actually commenced by sinking a shaft about 300 feet from the river, but was abandoned, on account of the influx of sand and water.

In 1807, the celebrated Cornish engineer Trevethick was placed in charge of the work, and, with great labor, succeeded in carrying a drift 5 feet 2 inches high, 2 feet 6 inches wide at top, and 3 feet wide at bottom, for a distance of 1,046 feet under the bed of the river, or within 33 yards of the distance required. Considering his skill or veracity impugned in respect of the direction followed, he made an opening in the top, to test the depth below the water, which dashed in and drove out the working part, nearly drowning Trevethick.

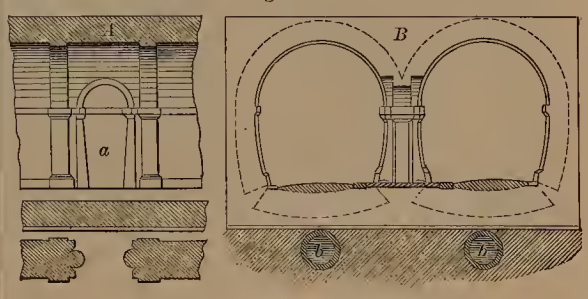
In 1824, the elder Brunel, Mark Isambert, devised plans for carrying out the work, and, a company having been formed for the purpose, it was commenced on the 1st of January, 1826, and by the 27th of April, 1827, 540 feet of the tunnel had been completed, when an irruption of water occurred. The leaks were stopped, the water pumped out, and the work advanced 50 feet farther, when a second irruption caused its total abandonment.

On this occasion, Brunel alone, of seven persons in the tunnel, escaped drowning.

In the progress of the work, Brunel made use of a sectional shield, designed by himself, to prevent the earth being crushed in by the pressure of the water above, and facilitate the excavation.

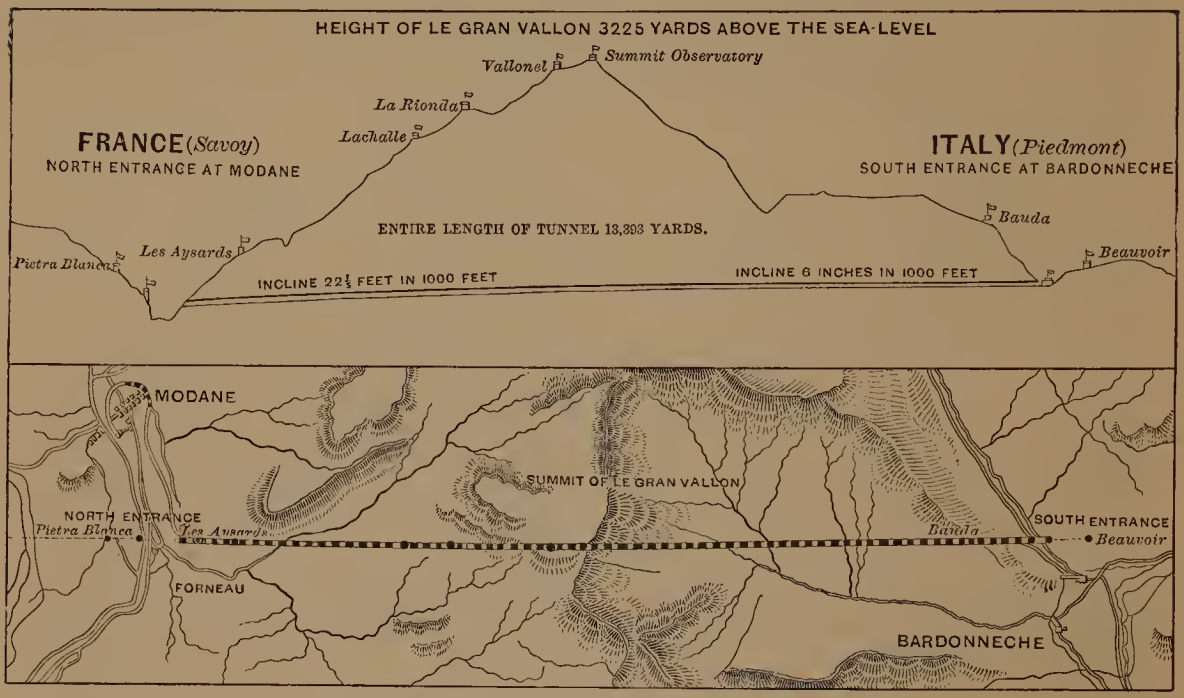
The tunnel was finally opened for foot-passengers, 1843. The length is 1,300 feet ; width, 35 feet ; hight, 20 feet ; clear width

Fig. 6775.




*Thames Tunnel Sections.*

Fig. 6776.




*Mont Cenis Tunnel* (*Section and Plan*).

of each archway, 14 feet; thickness of earth between the crown of the tunnel and the bed of the river, about 15 feet.

*A* is a longitudinal, and *B* a transverse section of this tunnel; *a*, one of the transverse arches connecting the two roadways; *b b*, drains.

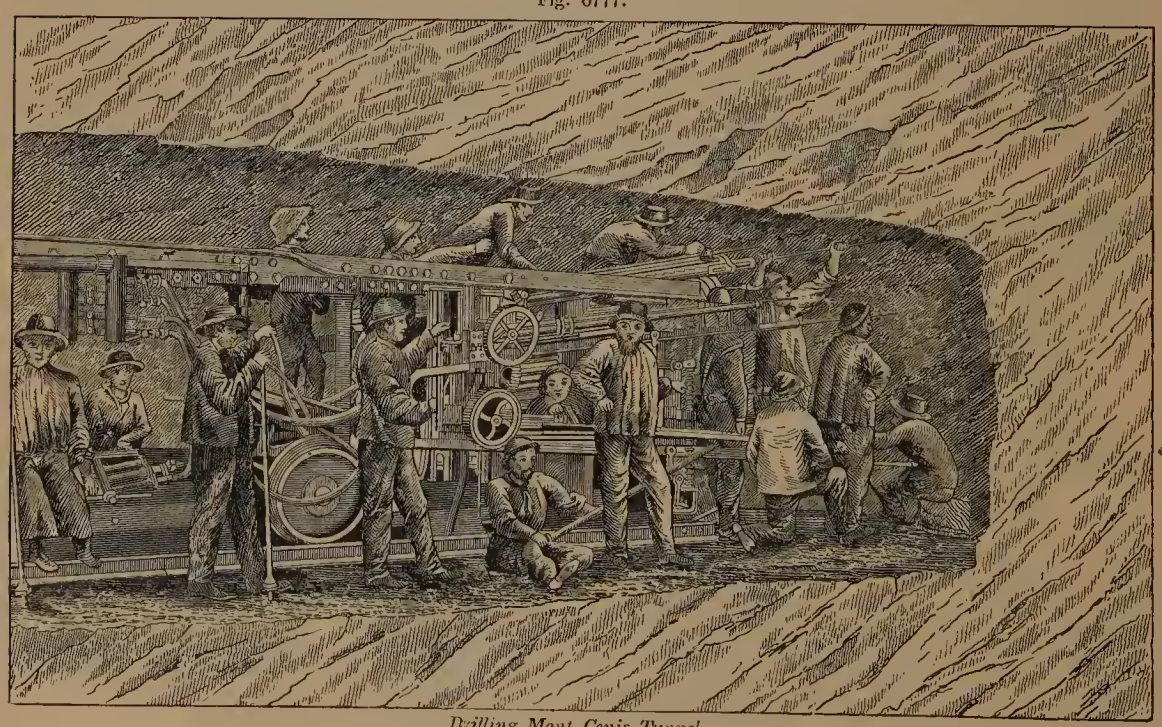
For submarine tunneling, see SUBMARINE EXCAVATION, etc.

The greatest completed tunnel of ancient or modern times is that generally known as the Mout Cenis, though it is, in fact, 15 miles southwest of that mountain.

This was first proposed by a Piedmontese road-contractor, Joseph Medail of Bardonnechc. In 1842, a geological survey was made, resulting in the choice of the linc at last actually taken. The work was actually begun in August, 1857, under the superintendeuce of Someiller, assisted by Grandis aud Grattoni, the Piedmontese government having grantcd a subsidy of 20,000,000 of francs toward carryiug it into effect. In 1855, Mr. Bartlett, an Euglish engineer, had patented a rock-drilling apparatus to be operated by air compressed by means of a steam-engine. The idea of using water, instead of an engine, to compress the air, occurred to the Piedmontese engineers, and was adopted. In the use of a compressed air-drill, with water, consists the great novelty in the execution of the work.

Fig. 6776 is a section through Le Gran Vallon, and a plan, showing the course of the tunnel. The hight of the mountaiu is 9,600 feet, and the highest point of the mass perpendicularly over the tunnel is 5,307 feet. The geological composition of the mass, along thc tunnel line, is, first, 2,350 yards of schist, then 396 yards of quartz, 2,954 yards of compact limestone, and the remainder, on the Italian side, is all schist. The dimensions of the excavation are: 25 feet 3½

Fig. 6777.



*Drilling Mont Cenis Tunnel.*

inches wide, at the base; 26 feet 2¾ inches wide, at the broadest part, with a semicircular top; 24 feet 7 inches high, at the Modane end, and 11¾ inches higher at the Bardonneche end. The roof and walls are cased with masoury.

From the north entrance, near Modane, the tunnel rises with an average grade of 1 in 45, or 117 feet 4 inches to the mile, to a point, just midway, 429 feet above the hight of the Savoy entrance. From this point to the Italian end, the inclination is but about 1 in 2,000, merely sufficient for drainage.

The exact length is 7½ miles 242 yards, or 4½ miles longer than the tunnel at Lanerthe, on the Paris, Lyons, and Mediterranean road, the longest ever previously constructed.

The excavation was effected simultaneously from both ends by boring and then blasting the face of the rock.

Air at the Italian end was compressed to six atmospheres, by means of hydraulic pressure obtained from the mountain streams. See PLATE X, opposite page 603.

The same apparatus supplied fresh air for ventilation, which was also assisted by exhaust apparatus at each end of the tunnel.

Fig. 6777 illustrates the operation of drilling. Seven drills pierced a series of holes in the rock about a yard in depth, and from 1 to 3 inches in diameter. Only the smaller holes were filled with nitro-glycerine, the larger being merely for decreasing the resistance of the rock. These took from five to seven hours to perforate, according to the hardness of the material. Previous to being charged, they were dried by blasts of air. The mines were successively exploded, beginning with the central ones, and the fragments removed by trucks. The progress in 24 hours was from 2 to 3 yards, depending on the nature of the rock.

The compressed air was conveyed in a cast-iron tube of 7.84 inches, and

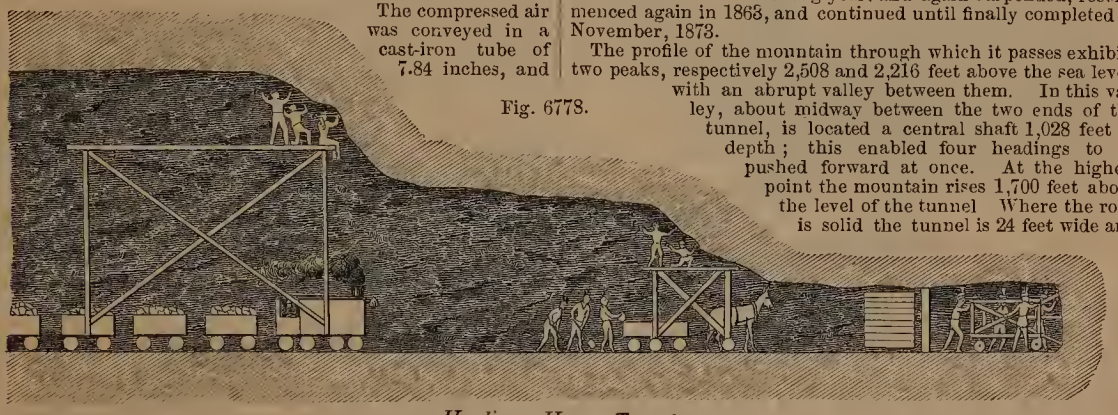


Fig. 6778.

*Heading; Hoosac Tunnel.*

made in sections of 6 to 8 feet long to the machine. The tube was provided with safety-valves, and whenever the pressure exceeded six atmospheres, the air escaped, and was conveyed by other tubes to the place of operation, for supplying the workmen with fresh air. The quantity of water consumed was 35.3 cubic feet per second, the fall being 144 feet. The ceremonial opening of the work took place September 17, 1871.

The length of the St. Gothard tunnel, now in progress, will be 48,651 feet, or 9 miles 377 yards. The altitude of the northern entrance, at Goescheneu, will be 3,703 feet above the level of the sea, and that of the southern entrance 3 850 feet. The summit in the tunnel will be 3,873 feet above the sea level, in order to give drainage in each direction; 7 in 1,000 to Goeschenen; and 1 in 1,000 to Airolo. 10 feet daily at each end is the usual rate of progress. The rock is solid at the northern portion, but requires lining and arching at the southern. That already traversed is for the most part mica gneiss and mica schist. The estimated cost is $ 10,000,000. The work is to be finished within eight years. The boring-machines used are those of Dubois and Francois, the general mode of working being similar to that at Mont Cenis, and the daily progress made appears to be rather more than double. It is feared now (1876) that this work will be abandoned.

The Hoosac tunnel, through the mountain of that name, on the railway between Troy, N. Y., and Greenfield, Mass., having a length of 4¾ miles, is the longest tunnel in the United States. It is cut through strata of mica slate of varying hardness, and was originally commenced about 1856. In 1859, when about 1,200 feet had been excavated, the work was suspended, recommenced in the following year, and again suspended, recommenced again in 1863, and continued until finally completed in November, 1873.

The profile of the mountain through which it passes exhibits two peaks, respectively 2,508 and 2,216 feet above the sea level, with an abrupt valley between them. In this valley, about midway between the two ends of the tunnel, is located a central shaft 1,028 feet in depth; this enabled four headings to be pushed forward at once. At the highest point the mountain rises 1,700 feet above the level of the tunnel Where the rock is solid the tunnel is 24 feet wide and 20 feet high, but where it is decomposed to such an extent as to render arching with masonry necessary, the dimensions are somewhat larger.

Previous to 1866, the drilling was done by hand, but since that period compressed-air drills of the Burleigh pattern have been employed. The general method of operation was similar to that at the Mont Cenis tunnel, a number of the drills being carried upon a frame mounted on wheels. Gunpowder, nitro-glycerine, giant powder, and dynamite were at different times employed for blasting, and fired by a magneto-electric apparatus. The blasting was effected in front of a movable bulkhead which was advanced as the work progressed, and the subsequent enlargement and finishing of the walls was for a considerable period done by hand, gangs of men working on scaffolds of various hights. This method was subsequently superseded by the employment of a number of atmospheric drills arranged upon a large carrier of tubular iron. The air for ventilation was in part furnished by the drills, and in part by a special ventilating pipe 8 inches in diameter, and delivering 2,000 cubic feet per minute.

Though railway tunnels are quite numerous in the United States, few are of great length, being all far exceeded by the Hoosac.

The Sand Patch tunnel on the Pittsburgh and Connelsville railway is 4,750 feet long.

The "Sutro" tunnel, so called from its projector, M. Adolph Sutro, is intended to cut the Comstock Lode 2,000 feet below its highest point, for the purpose of draining and ventilating the mines, and transporting ores therefrom to a point upon the Carson River, where their concentration may be cheaply and conveniently accomplished.

The estimated cost, including a large margin for unforeseen contingencies, is $ 8,000,000, and its dimensions are as follows: —

| | |
|---|---|
| Length of main tunnel | 21,178 feet. |
| Aggregate length of branches | 17,688 feet. |
| Aggregate depth of shafts | 4,220 feet. |
| Total | 43,086 feet. |

The section of the tunnel is 12 feet square, and is intended to afford passages for two lines of cars, each car having a capacity of 5 tons. A drain beneath the roadway of the cars will carry off all the water from the different mines.

A tunnel under the river Indus at Attock is 7,300 feet long; and it has been proposed to construct a submarine tunnel 4,800 yards in length under the Mersey at Liverpool. This, however, does not compare in point of magnitude with the schemes for uniting Scotland and Ireland by tunnelling St. George's Channel, or the venturous plan for uniting England and France by means of a tunnel. The soundings and borings for this work have already been made (1876).

Great accuracy has been attained in the alignment of tunnels so as to secure accurate meeting when working from both ends, or from several additional intermediate points. In making the Musconetcong tunnel, 5,000 feet long, the estimated length deduced from chaining and leveling over a mountain 450 above grade, varied from the actual length 6 $^{4}{}_{10}''$; the center lines of the headings varied $^{1}{}_{300}''$.

The Hoosac tunnel, 25,031 feet long, with an ascending grade of 26 $^{4}{}_{10}'$ to the mile, had an error of alignment when the headings met of $^{9}{}_{10}''$, and of level $1\,^{1}{}_{2}''$.

The Mont Cenis tunnel, 30,326 feet long, level on Italian side 435 feet above the French entrance, and the level in the middle 10 feet above the Italian entrance, the error in alignment was 18″, and in level 24″; the French heading above the Italian.

The cost of single-track tunnels in Pennsylvania was given as follows to the writer: —

Driving and timbering; soft rock. $ 3 to $ 4½ per cubic yard. Usual estimate, 14 cubic yards per lineal foot; the cutting out being wide enough to timber in. Price up to $ 6 for hard rock.

The estimated cost for the proposed Jones's-fall tunnel, Baltimore, is $ 2 per cubic yard. $ 145 per lineal foot.

The cost of the Mont Cenis tunnel was $ 300 per lineal foot.

The Kilsby double track in England, through difficult quicksands, was $ 262 per lineal foot.

Terre Noire, on the Paris, Lyons, and Mediterranean Railway, cost $ 50 per foot.

The Haeunstein tunnel, between Basle and Berne, Switzerland, cost $ 133 per lineal foot.

The Hoosac, through mica slate and quartz, with a working shaft 1,000 feet in depth, $ 300 per lineal foot.

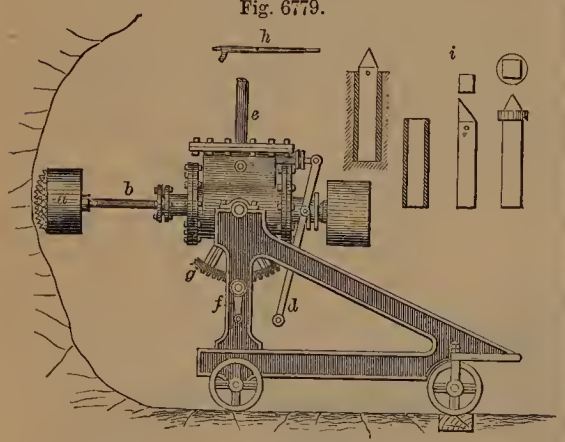
The entire cost of the Fourth Avenue underground railway of New York, $ 6,395,070, 4½ miles, $ 205 per lineal foot.

2. A level, adit, or drift in a mine.
3. A funnel.
4. A chimney or flue.

**Tun'nel-bor'er.** (*Civil Engineering.*) A ram, operated by compressed air, for making excavations through rock. It is said that the battering-ram was used by the ancient Romans in making tunnels where their aqueducts had to pass through rocky strata.

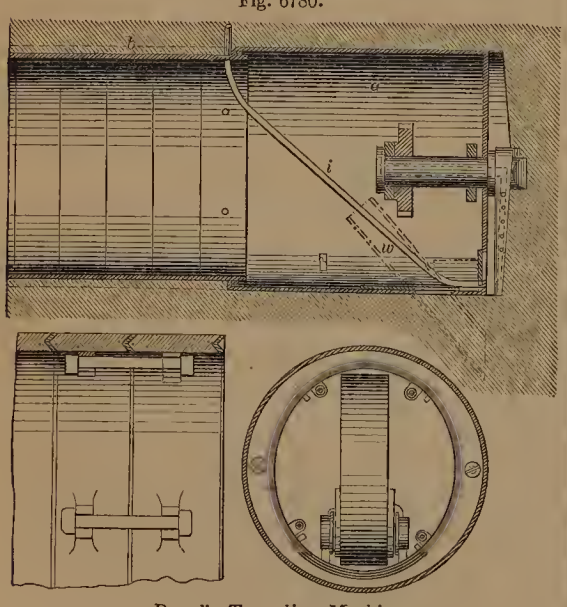
The present device was invented by Captain Penrice, an English engineer, and is reported to have been worked with satisfactory results in the quarries of Vaugirard, near Paris. *a* is the ram-head; its face is studded with removable cutters; it is fixed on the pistou-rod *b*, which is provided with a heavy counterweight *c*, and is reciprocated by the admission of air alternately to either side of the piston through valves operated by the hand-lever *d*. The air is received through the pipe *e*, connected with a flexible tube leading to the compressed-air engine outside of the tunnel. The apparatus is mounted on trunnions upon a carriage, and the vertical angle of presentation of the ram is varied by means of the lever *f*, which carries a pinion gearing with the toothed sector *g*. *h* is a handspike, which is inserted in holes in the rims of the truck-wheels for the purpose of maneuvering the carriage. *i* shows the cutting devices.

Fig. 6779.




*Tunnel-Borer.*

Fig. 6780.




*Dowd's Tunneling-Machine.*

Fig. 6780 is Dowd's tunneling-machine for river-beds and treacherous ground. It has a cylindrical or elliptical shield *a* which is pushed against the heading of soil or silt, and iron sections are built up behind it as it advances, forming a tunnel *b*; a packing is introduced at the junction of the two. A scraper in advance of the tube is revolved by gearing and any suitable motor inside. Water is introduced through a tube in the axis of the scraper-arm. The mud is withdrawn from the face of the shield and ejected by pipe *i* above the tunnel casing. The tube *w* is applied when an obstructing stone or old anchor may be met with, to excavate a hole and sink the obstruction out of the way. One of the lower figures shows the mode of locking the tubes together, and the other the mode of running in a section.

**Tun'nel-head.** (*Mining.*) The top of a furnace, at which the materials are put in.

**Tun'nel-kiln.** (*Lime-burning.*) One in which lime is burnt by coal; as contradistinguished from a *flame*-kiln, in which wood is used.

**Tun'nel-net.** (*Fishing.*) One with a wide mouth and narrowing in its length.

**Tun'nel-shaft.** (*Engineering.*) One dug from the surface to meet a tunnel at a point between its ends.

**Tur'ban.** An Oriental head-dress made of a cloth wound around the head. The shapes, materials, size, and mode of wearing vary much in different countries. In India it is a strip of cloth usually from 9 to 12 inches wide and from 5 to 25 yards long, but has been known to be a yard wide and 60 yards in length. The most common color there is white; next red, yellow, green, blue, black, buff, shot colors, and gray; of cotton, silk, and of printed colors.

**Tur'bine.** A form of water-wheel; also known as a *vortex-wheel*. It is usually horizontal; that is to say, its axis is vertical. It has curved buckets. It was invented by Fourneyron in 1823, and the first one was made in 1827. In the original form, the discharge is *outward*, the water in the central chamber being directed upon the buckets by curved chutes.

In the *central-discharge* turbine, the buckets expose their concavities outward to receive the impact of the water from the surrounding chutes.

In the *Jonval* turbine, the water is received above and the discharge is downward, that is, parallel to the axis of rotation.

Some variations may be noticed.

The water is introduced at the outside and takes a curved course, discharging downward; or, being introduced from the center, is curved downward.

A turbine above delivers the water into a turbine below, rotating in a different direction.

Several turbines on one shaft receive water from a series of chutes, the number of the latter being proportioned to the quantity of water available, so that one or more wheels may be used, as expedient.

The axis may be horizontal, or, the axis being vertical, the water may be received from below. See WATER-WHEEL.

Turbines are divided into *high* and *low pressure*, the former being relatively small, revolving at a high rate and driven by elevated heads of water. The *low pressure* are relatively larger, contain a larger volume, and run at a slower rate. In the Black Forest of Baden, turbines are running with heads of 72 and 854 feet, and having diameters of 20 and 13 inches respectively. Low-pressure turbines are doing good duty with large volumes of water having only 9 inches head.

The theory of the turbine was investigated by Euler, whose theory was to construct a horizontal wheel to turn on a vertical axis, and be driven by water directed from a reservoir immediately above it upon floats of curved form fixed to its circumference. The curvature to be given to the floats was such, that at the top, where the impulse of the water was to be first received, they should be nearly vertical, while at the bottom they should approach the horizontal. Within the reservoir he proposed to place a set of curved plates to give direction to the issuing water, in which the construction above described should be reversed, the summits of the *directrices* being nearly vertical, and their lower edges nearly horizontal. By this arrangement it would happen that the water at its first discharge would strike the faces of the floats or pallets nearly in the plane of rotation; and before its final escape, it would transfer to the wheel nearly all its living force. No water from the reservoir was to be admitted to the wheel except that which was directed on the pallets.

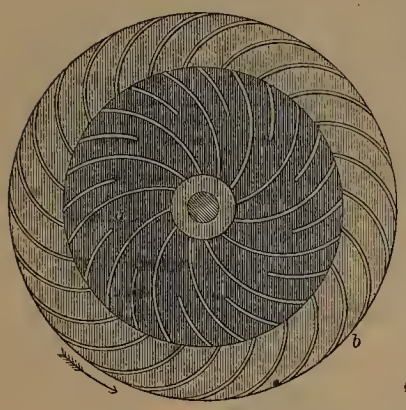
The turbine is also known as the *reaction-wheel* (see page 1887). The first exemplification of the force developed was in the Barker mill (see page 231).

Fig. 6781 represents the Fourneyron *outward*-flow wheel *b*, with the interior directrices *a*, which pro-

ject the water upon the floats of the wheel. The escape of the water is outward.

The illustration shows none of the surroundings, but is a simple plan view. The direction of motion is shown by the arrow; the water acts with a pressure in proportion to the hight of the fall. The efflux of the water is regulated by a hollow cylindrical sluice, to which a number of stops, acting simultaneously between the guide-curves, are fixed. With this short cylinder, or hoop, they are all raised or lowerod together by means of screws communicating with a regulator or governor, so that the opening of the sluice and stops may be increased or diminished in proportion as the velocity of the wheel may require to be accelerated or retarded.

Fig. 6781.



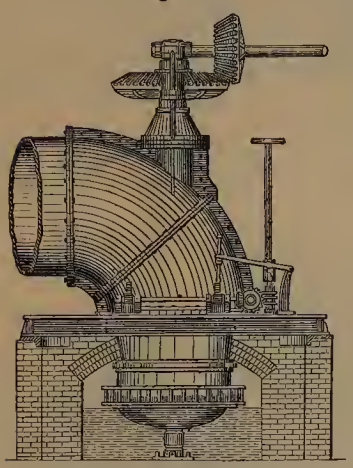
*Fourneyron's Turbine.*

Fig. 6782 is the Boyden outward-flow turbiue on the Fourneyron principle.

Fig. 6783 has the reverse movement, or *inward* flow; the water entering at all points around the circumference of the wheel and escaping at the center and downward.

In the illustration, the parts are represented as detachable, so as to reach any stones or brush which may become jammed. The sections occupy grooves in the faces of the top and bottom plates, so as to be removable when the upper plate is lifted.

Fig. 6782.



*Boyden's Outward-Flow Turbine.*

Kindleberger's turbine is also of the *inward*-flow and center-vent variety. Its peculiarity is in the mode of applying water and graduating the area of the gated openings.

Each of the twelve gates has a strong brass spiral spring inclosed in a box, so that if foreign matters, such as sticks, should become jammed in the water-way, the gate closing that particular opening may be allowed to gape when the other buckets are closed by the rotation of the annular sleeve and set of levers, one of which latter rotates each bucket on its pintle. The sleeve is rotated by a segment rack and pinion, the latter being rotated by a shaft which passes upward to the floor above.

The obliquity of the bucket edges relatively to the gated openings is such that the water impinges constantly upon an equal area of bucket surface, the forward edge of each coming first into action.

The Jonval turbine has *downward* flow, the guides for the water being above.

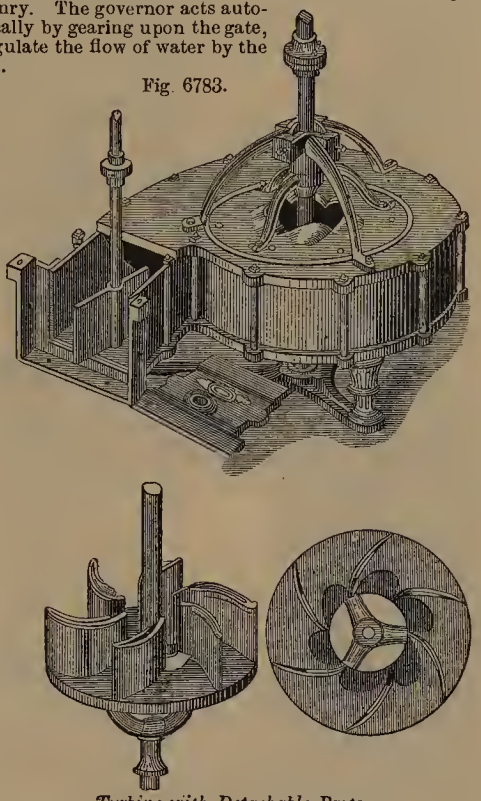
Fig. 6784 is the Watson turbine, on the Jonval principle, with its guides above and downwardly discharging wheel beneath. The draft-box is a flume or tube extending downward from the wheel-case, so as to obtain the benefit of a considerable fall, with the wheel at or near the top instead of at the foot of the fall.

The draft-box is the invention of the Parkers.

The Swain wheel is a combination of the *inward* and *downward* flows.

Fig. 6785 is a sectional elevation of a 60-inch Swain turbine; an eighth-turn casing, connecting by means of a feed-pipe with the gate-hoisting apparatus, is supported by framing upon the masonry. The governor acts automatically by gearing upon the gate, to regulate the flow of water by the speed.

Fig. 6783.

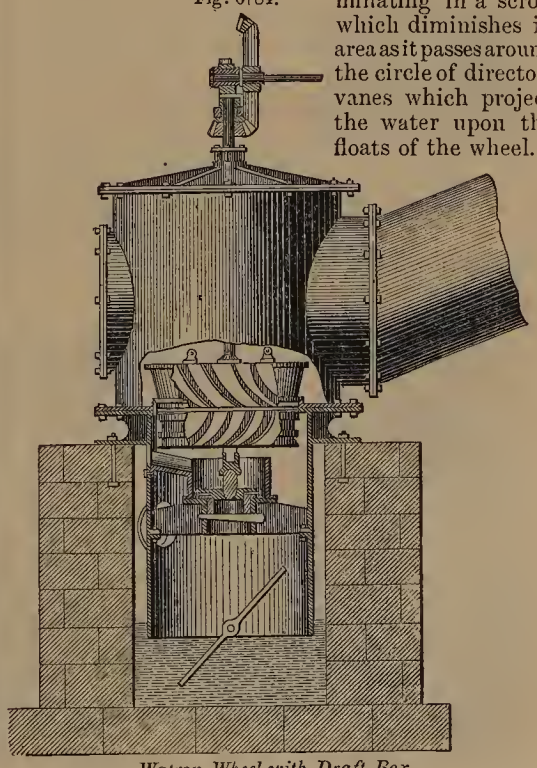


*Turbine with Detachable Parts.*

Fig. 6786 is the Chase turbine, receiving the water on its exterior, and discharging it downward. The wheel is shown with the case removed, and a small part of the lower rim, to show the lower ends of the buckets.

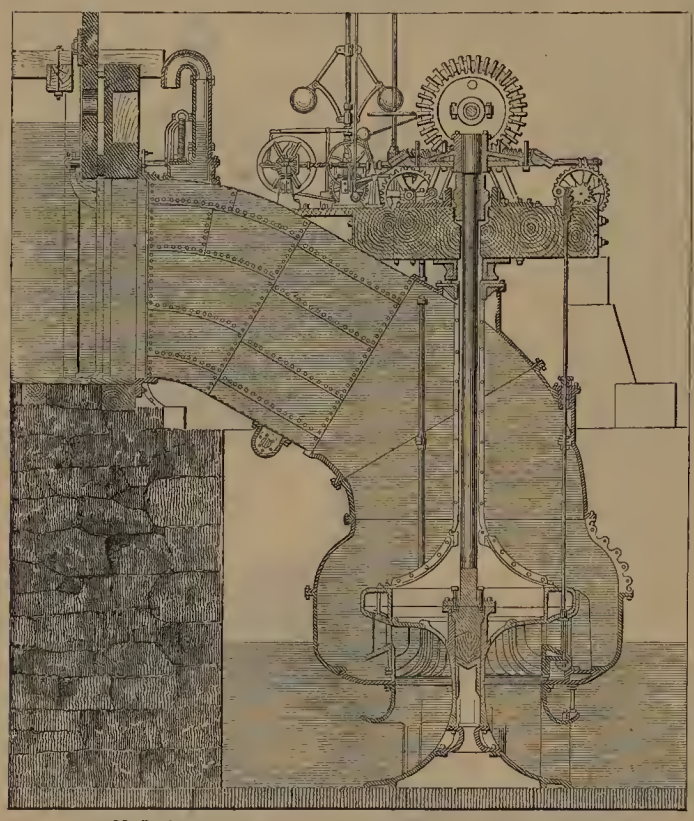
Figs. 6787, 6788, show another modification. The water surrounds the wheel, and is projected inward upon the double-winged floats, which discharge the water upward and downward, not centrally; the tube of supply terminating in a scroll which diminishes in area as it passes around the circle of director-vanes which project the water upon the floats of the wheel.

Fig. 6784.



*Watson Wheel with Draft-Box.*

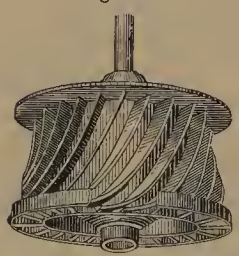
Fig. 6785.



60-*Inch Swain Inward and Downward Flow Turbine.*

The wheel is inclosed in a cylindrical box, which is open beneath and above; the water enters upon the point — as it may be termed — of the double-winged float, and passes equally downward and upward, escaping in directions parallel to the axis.

Fig. 6786.



*Chase Inward and Downward Flow Turbine.*

The Leffel double turbine has two independent sets of buckets, one a vertical and the other a central discharge, each receiving its water from the same set of guides at the same time, and the water leaving each wheel independently. The two sets are cast together and to the same shaft (Fig. 6789).

The Girard *free turbine* is so called from its having a pressure of air in the casing into which the wheel discharges, to allow the wheel to run in air and avoid the friction of tail-water. This pressure is, of course, in diminution of head, but it is supposed that the gain is greater than the loss.

The reversal of the action of the turbine driving it by steam-power in the direction contrary to its natural motion as a water-wheel forms the centrifugal or centripetal pump, according to whether the turbine be on the *inward* or the *outward* flow principle. See CENTRIFUGAL PUMP; CENTRIPETAL PUMP; PROPELLER PUMP, Fig. 3977.

Ruthven's English patent of 1849, for a hydraulic ship propeller, acting by a steam-driven turbine-wheel, ejecting the water aft, was tried in 1866 on the "Water-Witch." It was termed the NAUTILUS PROPELLER (see page 1515). See also HYDRAULIC PROPELLER, pages 1149, 1150.

Several tables have been constructed to indicate the powers and rates of wheels of varying diameters under different heads.

They contain the sizes of the wheels in inches of diameter: the head in feet; the cubic feet of water per minute; the number of revolutions per minute; the horse-power.

**Tur'bine-dyn'a-mom'e-ter.** See TESTING-MACHINE, Fig. 6331.

**Tur'bine-pump.** A form of pump, — the turbine reversed. It is driven by power, and the floats, catching the water, force it up the chute.

*a* (Fig. 6791) is a turbine-case; *b* an air-cock for escape of water when the starting-pump is filling the case.

**Tu-reen'.** (Fr. *terrine.*) (*Domestic.*) A large deep table-dish for soup, etc.

**Turf-cut'ter.** A *paring-plow.*

Horses excavated in the turf, exposing the colored soil or subsoil, are found on steep hills in England, — as the *red horse* of Warwickshire, a memorial of Richard Neville, Earl of Warwick, whose castle of Fullbrook, 8 miles off, faced the hill. On this hill the earl killed his horse just before the battle of Towton. The white horse of Marlborough Downs, near Calne, shows the chalky subsoil, and is visible 12 miles distant. The dark mark forming the pupil of the eye is a mound of turf 5 feet across, measured by the author's umbrella. It is believed to be a memorial of the victory of Alfred over the Danes, A. D. 871. The horse is an ancient national emblem, being shown on British coins.

"And as now
Men weed the white horse on the Berkshire hills
To keep him bright and clean as heretofore."

TENNYSON'S *Enid.*

**Turf-drain.** (*Husbandry.*) One covered with turf.

**Turf-hedge.** (*Husbandry.*) A bank around a field, made of turfs or sods.

**Turf-house.** A hovel made of sods.

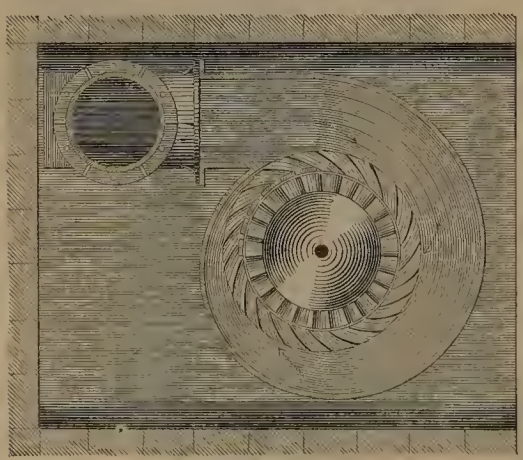
**Turf'ing-ir'on.** A spade for cutting sods.

**Turf'ing-spade.** A *turf-spade.*

**Turf-plow.** A plow adapted to remove the sods from the surface of the ground preparatory to deep plowing, or for destroying grubs, etc. That illustrated (Fig. 6792) is an English invention. The vertical cutter which precedes the share has an eccentric movement by which the depth of cut may be regulated.

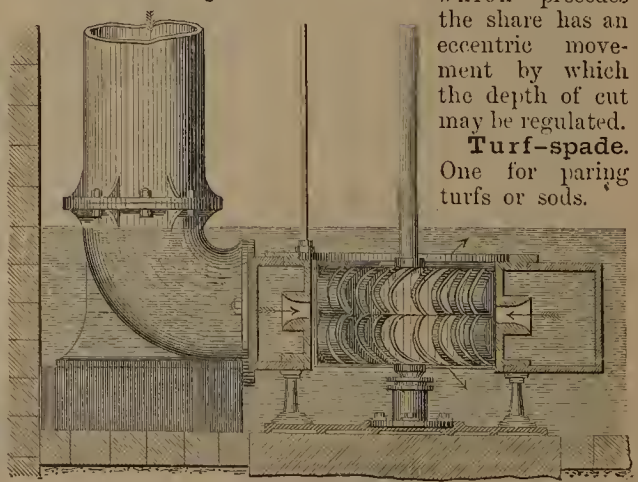
**Turf-spade.** One for paring turfs or sods.

Fig. 6787.



*Schiele's Inward-Flow Turbine (Plan, showing Scroll).*

Fig. 6788.

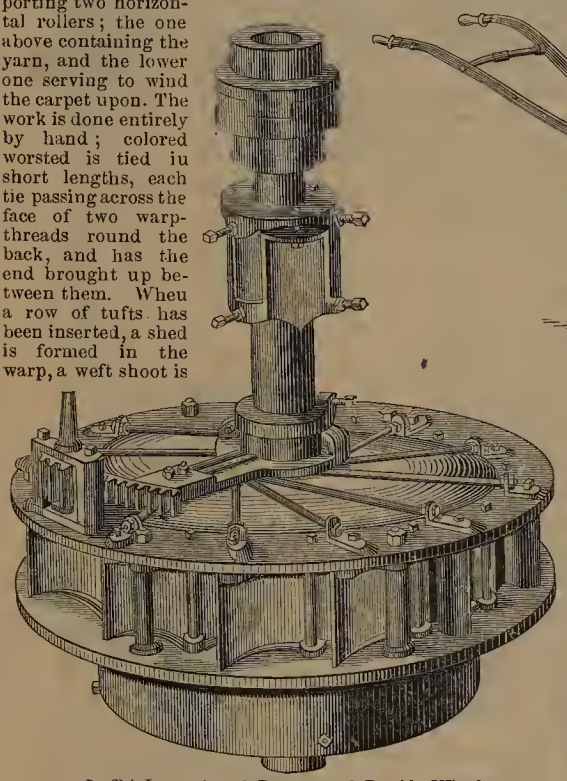


*Schiele's Inward-Flow Turbine (Section and Partial Elevation).*

**Tur'key-car'pet.** Turkey-carpet is formed of a chain and weft of strong linen yarn and tufts of worsted tied into the fabric in the course of manufacture.

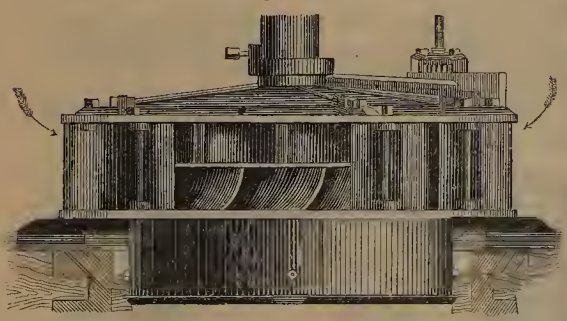
The loom of Eastern countries consists of two upright pieces fixed at a certain distance apart and supporting two horizontal rollers; the one above containing the yarn, and the lower one serving to wind the carpet upon. The work is done entirely by hand; colored worsted is tied in short lengths, each tie passing across the face of two warp-threads round the back, and has the end brought up between them. When a row of tufts has been inserted, a shed is formed in the warp, a weft shoot is passed across from right to left and returned, and is beaten down by hand beaters. This binds the whole together, and thickens the web.

Fig. 6789.



*Leffel Inward and Downward Double Wheel.*

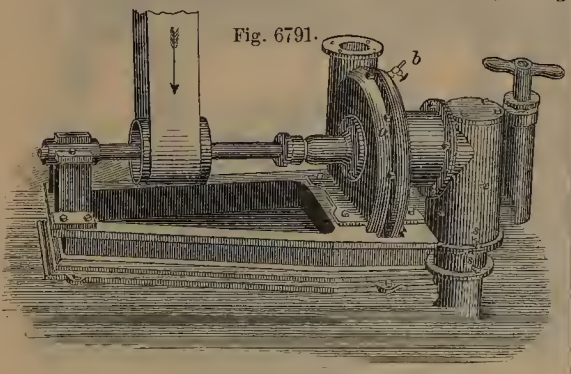
Fig. 6790.



*Leffel Double Turbine Wheel (Case partly removed).*

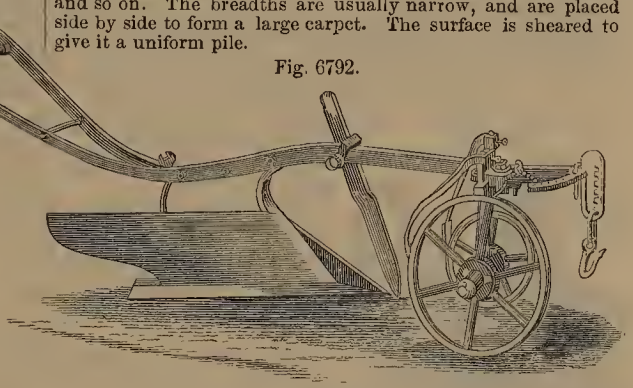
The Turkey-carpet loom of Europe is similar; the posts and beams are similarly arranged, the upper roller carrying strong linen yarn which passes down through heddles to the lower beam. The weaver is seated, as at the common loom, and having thrown a weft thread once or twice across, he fastens to every thread of the warp, by a peculiar twist, a small bunch of yarn, colored according to the pattern of the design before him. One row of tufts being inserted, he passes a linen weft through the shed, and drives it well against the web, locking the tufts in position. He then twists in another row of tufts, and so on. The breadths are usually narrow, and are placed side by side to form a large carpet. The surface is sheared to give it a uniform pile.

Fig. 6791.




*Turbine-Pump.*

Fig. 6792.



*Turf-Plow.*

**Tur'key-red.** The brilliant color known by this name is produced by a series of processes differing slightly at different places, but not essentially varying from the following French method: —

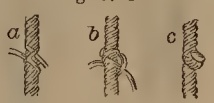
The cloth is steeped in an oily liquid; then allowed to ferment or sweat for several hours, and exposed to the heat in a hot closet for several hours longer; these processes are three times repeated, after which the cloth is steeped in an alkaline liquid, and then in a solution of alum and galls, next in lime-water, then boiled in a solution of madder, washed and dried, again steeped in alum and galls, and boiled with madder; after three successive boilings with soap, pearlash, and other ingredients, it is exposed to the air for some time, and finally boiled with water and bran and then dried.

**Tur'key-stone.** A fine quality of oil-stone from Turkey, — *novaculite.* Sir Thomas Gresham paved the old Royal Exchange, London, with Turkey-stone.

**Turk's-head.** (*Nautical.*) *a.* An ornamental knot, like a turban, worked on to the end of a rope.

*b.* A knot formed on a man-rope or other standing rope. It is formed by taking a round turn around the rope with a piece of log-line, crossing the bights on each side of the round turn, sticking one end under one, and the other under the other cross, as shown at *b*, and following the lead until it shows three parts all around, as at *c*.

Fig. 6793.



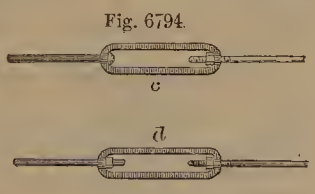

*Turk's-Head.*

**Turn.** (*Mining.*) A pit sunk in a drift.

**Turn-bench.** A small portable lathe used upon a bench or desk by watch, model, and instrument makers.

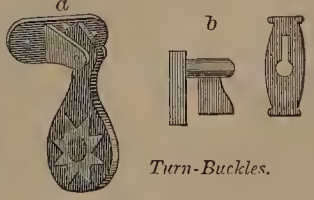
**Turn-bridge.** A *swivel* or *swing* bridge. See SWING-BRIDGE; PIVOT-BRIDGE.

Fig. 6794.




**Turn-buck'le.** 1. (*Hardware.*) A form of shutter-fastening having a gravitating catch *a* (Fig. 6794).

2. (*Ordnance.*) An analogous device used for securing the free ends of the implement-chains in a gun-carriage and the cover of the ammunition-chest (*b*).




*Turn-Buckles.*

3. (*Nautical.*) A link used for setting up and

tightening the iron rods employed as stays for the smoke-stack of a steamer or for similar objects (*c d*).

**Turn-cap.** A turning chimney-top or cowl, presenting its mouth to leeward.

**Turned House.** (*Mining.*) A term used when a level, in following branches of ore, is turned out of the original direction.

**Turn-file.** A burnisher used in throwing up slight burs on the edges of the comb-maker's files, the teeth of which are originally made by the file and not by the chisel. Used by workers in horn, tortoise-shell, iron, and bone.

Fig. 6795.

*Turning Pottery.*

**Turn'ing.** 1. Wood or metal shaping, the object being rotated on an axis and the tool presented to it. See LATHE.

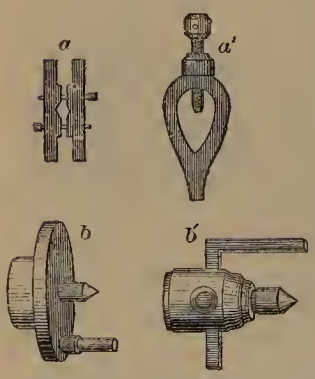
2. (*Pottery.*) A process for smoothing thrown pottery, consisting in turning off the exterior surface of the partially dried vessels, which are in what is called the *green* state. The moistened surface of the vessel adheres to the top of the rotating disk, while the turner removes a long ribbon of clay by means of a cutting tool. This being completed, and the green handle cemented on by *slip*, the vessel is cut loose by a wire and sent to be fired.

Some articles of small ware are *chucked* and turned in a manner closely analogous to that employed in the ordinary wood-lathe.

**Turn'ing-bridge.** A SWING-BRIDGE. See also PIVOT-BRIDGE.

**Turn'ing-car'ri-er.** (*Lathe.*) A device for holding metallic work while being turned in the foot-lathe. The work is clasped by the carriers *a a'*, which are caused to rotate by means of the drivers *b b'* fixed to the lathe-mandrel. See also DOG; DRIVER.

Fig. 6796.




*Turning Carriers and Drivers.*

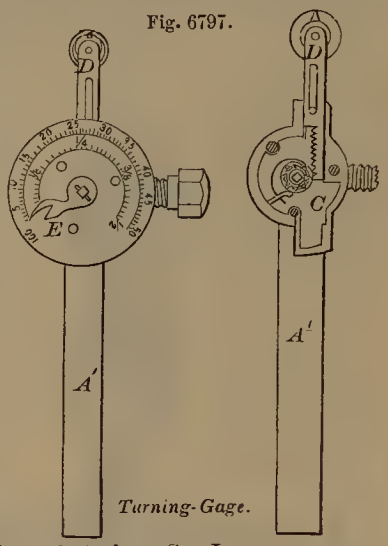
**Turn'ing-chis'el.** A chisel used by turners for finishing work after being roughed out by the gouge. There are several kinds. Some are rectangular, with an oblique whet, like a graver; others have a chisel edge, with two peculiarities: the chamfer for the edge is on both sides of the blade, and the edge is obliquely across the end of the blade. See TURNING-TOOLS.

**Turn'ing-en'gine.** A lathe.

**Turn'ing-gage.** An instrument to assist in setting over the tail-stock of the lathe, so that a given taper in a given length of work may be obtained.

To find the taper for a certain number of inches in length, the shank *A'* of the gage is inserted in the tool-stock of the lathe; a straight shaft-arbor with a uniform diameter is then adjusted upon the center points of the lathe; the tail-stock carrying the dead center is then set over either to or from the tool, as the case may require, so that when the tool is traversed back and forth upon the surface of the shaft the distance through which the taper is to be turned, by moving the slide-rest of the lathe, it shall force in the self-adjusting bar *D*, thereby rotating the shaft *C*, carrying the head with the pointers *E* sufficiently to indicate the exact taper required; this is done by approximation, the motion of the pointer through an inch, its multiple, or its fractions, on the dial through the given traverse of the slide-rest, giving the required position of the back center.

Fig. 6797.



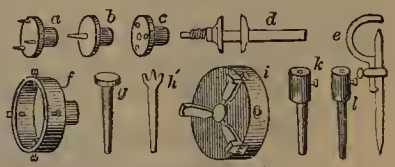

*Turning-Gage.*

**Turn'ing-in.** The process of *strapping* a *dead-eye;* that is, bending a rope tightly around it in the *score.*

**Turn'ing-lathe.** A machine for turning wood or other materials to symmetrical forms. A common form for wood is called a *pole-lathe.* See LATHE.

**Turn'ing-lathe Chuck.** Fig. 6798 shows various forms of lathe-chucks and other machine appliances.

Fig. 6798.




*Turning-Lathe Chucks.*

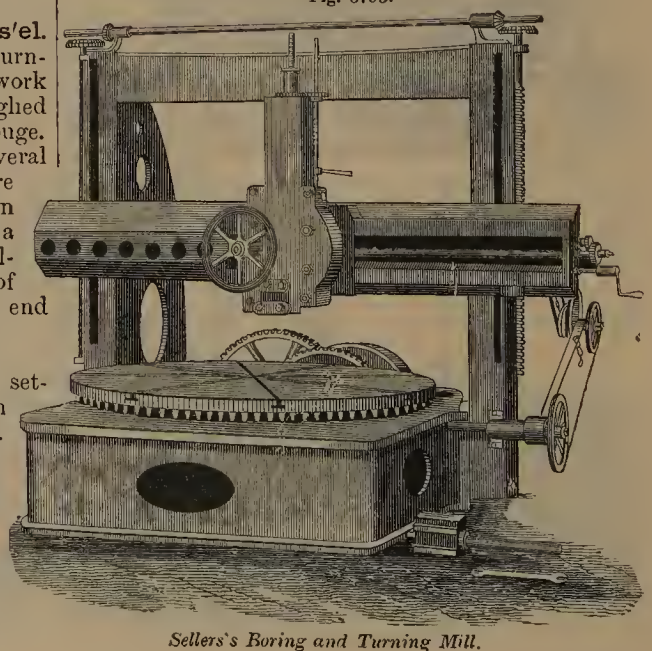
*a*, three-pronged chuck.
*b*, screw-chuck.
*c*, steel arbor, for holding circular saws, emery-wheels, grindstones, etc.
*d*, face-plate, for holding wooden chucks, polishing-wheels, etc.
*e*, Turner's sizer, or caliper.
*f*, shell-chuck.
*g*, drill-rest.
*h*, spur-chuck.
*k*, plain drill-chuck, with set-screw.
*l*, drill-chuck, with square hole for bits.

**Turn'ing-ma-chine'.** (*Boot-machine.*) One for turning boot-legs after the seams have been sewn and rolled.

**Turn'ing-mill.** A form of horizontal lathe or boring-mill. It has a compound slide-rest and boring-bar.

The holder for the boring-bar is readily removed, and a turn-

Fig. 6799.



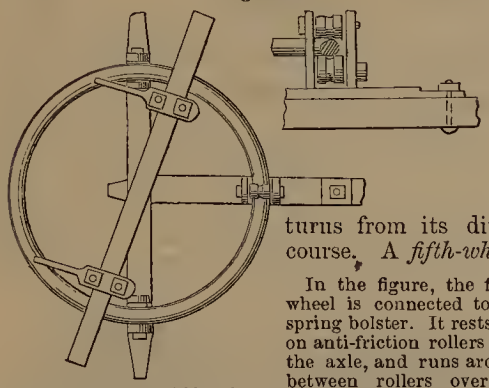
*Sellers's Boring and Turning Mill.*

ing-tool substituted: the feed is self-acting in all directions and at all angles; the boring-bar has a quick return motion; the face-plate rests in an angular bearing similar in shape to the slide of a planing-machine; an adjustable center step takes such amount of the vertical strain as may be desired. See also HORIZONTAL LATHE, Fig. 2562; also BORING-MACHINE.

**Turn'ing-piece.** A camber top-board used as a centering for a discharging arch.

**Turn'ing-plate.** A circular plate above the front axle, where the bed moves upon it as the carriage

Fig. 6800.



*Turning-Plate, or Fifth-Wheel.*

turns from its direct course. A *fifth-wheel*.

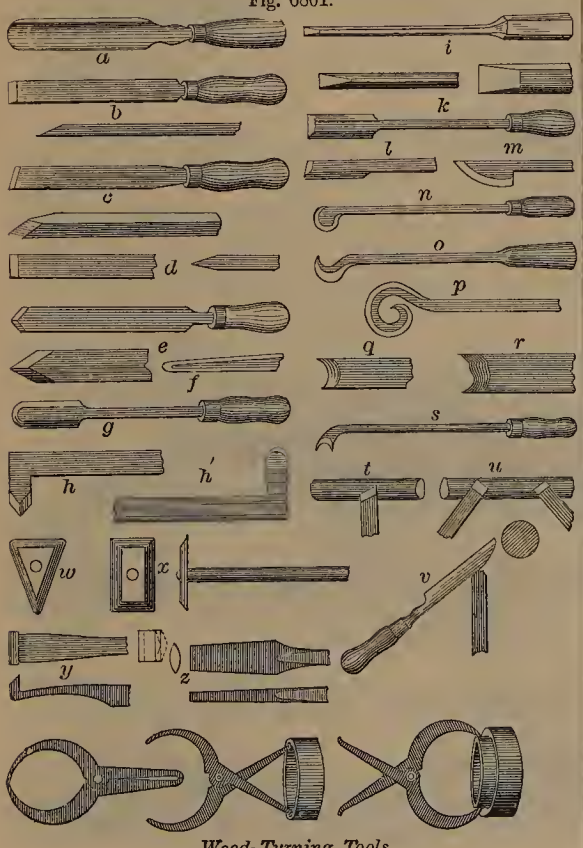
In the figure, the fifth-wheel is connected to the spring bolster. It rests upon anti-friction rollers over the axle, and runs around between rollers over the central reach.

**Turn'ing-saw.** A saw having a thin blade stretched in a frame, and capable of making a curved kerf. Used in sawing scroll-work, chair backs, etc. Otherwise known as a SWEEP-SAW, BOW-SAW, FRAME-SAW, or SCROLL-SAW (which see).

**Turn'ing-tools.** The cutting implements used by turners vary considerably according to the nature of the material to be operated on and the character of the work, whether it is to be plain or beaded, or employed on the exterior or interior of the work.

For turning the softer woods, chisels and gouges having cutting angles of 25° to 30° are employed; for harder woods this

Fig. 6801.




*Wood-Turning Tools.*

angle is made as much as 40°. The edge of the gouge is ground elliptical, and its central portion is that principally used: it is employed for getting the first rough cylindrical surface on the work, the convex side being turned downward, and also for turning out hollows. Hook tools *o p* are also used for surfacing. For finishing, chisels generally having an oblique edge, doubly beveled, are employed.

Square-edged chisels, with rather thicker edges than those ordinarily employed in carpentry, are in frequent use for smoothing. The *broad y* is used for this purpose. It is held underhand. Other forms of *broad*, as *w x*, are also used, principally upon large work, the plank way of the grain.

The side tool *z* is used upon insides of cylinders.

The tools for hard wood and ivory are beveled on one edge only, which has consequently nearly double the thickness of that used for soft wood.

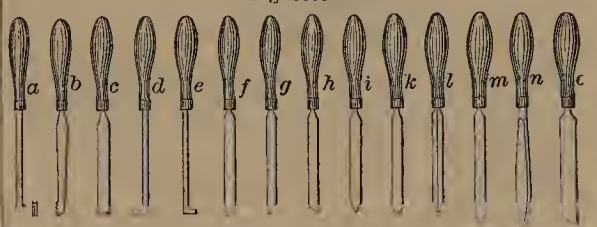
*a* (Fig. 6801), gouge; used for roughing-out work.

*b*, chisel; plan and section.
*c*, sharp-pointed chisel.
*d*, doubly beveled chisel.
*e*, obtuse-pointed chisel.
*f g*, round-pointed chisel.
*h h'*, inside chisels.
*i*, ripping-chisel, for starting an opening.
*k l m n*, wood-turners' chisels.
*o p*, inside tools.
*q r s*, chisels for turning beads, etc.
*t u* illustrate modes of applying the chisel.
*v*, gouge in position on the rest.
*w x y*, broads.
*z*, side-tool, for insides of cylinders.
*a'*, calipers.
*b'*, calipers applied for measuring inside diameters.
*c'*, calipers applied for measuring exterior diameters.

Fig. 6802.

*Inside Tools.*

Fig. 6803.




*Metal-Turning Tools.*

*a* (Fig. 6803), milling-tool, with wheel.
*b c*, chasers, for cutting screws.
*d e*, bent inside tools,
*f*, flat tool,
*g h*, right and left side tools,
*i*, point tool,
*k*, round-point tool,
} for brass, ivory, hard wood, etc.
*l*, square graver, for metal.
*m*, cutting-off tool,
*n*, turning-gouge,
*o*, turning-chisel,
} for wood.

Fig. 6802 shows *inside* tools.

For turning the concave and convex surfaces of rubies or sapphires, used for the jewels of watches and chronometers, a diamond-drill such as is shown in Fig. 6804 is used; *a* represents the flat surface and *b* the edge of such a tool. It may also be used for engraving extremely fine lines. The diamond was first used for turning by Ramsden in cutting the hardened steel screw for his dividing-engine.

Fig. 6804.

*Diamond-Turning Tools.*

See under the following heads: —

Astragal tool.
Bead-tool.
Bevel-tool.
Bottom-tool.
Broad tool.
Chisel.
Comb.
Cranked tool.
Flat tool.
Gouge.
Hanging-tool.
Heel-tool.
Hook-tool.
Inside tool.
Nail-head tool.
Parting-tool.
Screw-cutting tool.
Skew-chisel.

**Turn'ing-up.** (*Bookbinding.*) Taking the round out of the back, while the fore edge is cut.

**Tur'nip-cut'ter.** A machine for slicing roots for animal feed. See ROOT-CUTTER, etc., pages 1975, 1976.

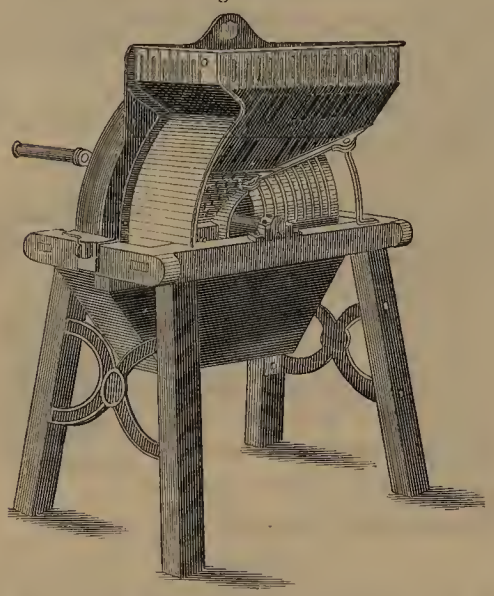
**Tur'nip-pull'er.** (*Husbandry.*) An implement, but little used in this country, for pulling turnips out of the ground.

**Tur'nip-pulp'er.** (*Agriculture.*) A machine

for pulping turnips, etc., to be used as food for cattle.

Hornsby's (Fig. 6805) has a rotary disk containing a number of cutters and corresponding apertures through which the pulp falls. The roots are placed in a hopper, and fed by their own

Fig. 6805.



*Hornsby's Turnip-Pulper.*

weight to the cutters, and the disk has parallel projections at right angles to its face, which prevent the pulp from escaping except through the apertures arranged for that purpose, and from which it falls into the trough.

**Turn'key.** An instrument to extract teeth; not much used now. It was known to the ancients, who had instruments called *pelican*, on account of resembling the bill of said bird. The stump-extracting machine used in this country by farmers is patterned after the *turnkey*.

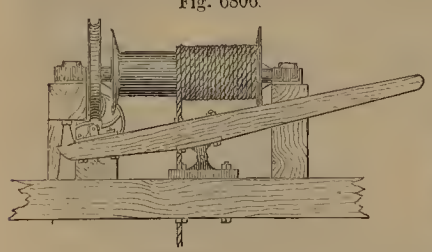
**Turn'out.** (*Railway.*) A railway siding.

**Turn-o'ver Boil'er.** A form of boiler in which the flues were *turned over* the fire-box or furnace. It was one form which the boiler improvement assumed in the gradual conversion of the old Cornish boiler into a more compact form.

**Turn-o'ver Gear.** (*Saw-mill.*) An application of machinery for hauling up logs from the saw-mill to the log-carriage, or turning the log on the carriage after slabbing one side.

A simple and compact form is shown in Fig. 6806, in which a lever brings a gear into contact with a worm-wheel on the axis of the rope-drum, and so hauls upon the rope which leads to

Fig. 6806.



*Turn-over Gear.*

the pond or over a pulley to a cant-hook, by which the log is turned.

**Turn'pike.** 1. A toll-gate across a road.

2. A proprietary road, where toll is collected. The name has come to signify one which is graded and either *macadamized* or graveled, so as not to be mere mud. The first American turnpike act was in 1796, —the National Road from Baltimore to Illinois. See PAVING; ROAD.

3. A TURNSTILE (which see).

4. A winding stairs.

5. (*Fortification.*) A beam filled with spikes. A *cheval de frise*.

**Turn'pike-stair'case.** A winding stair, constructed around a central newel or post.

Fig. 6807.

*Turn-Pin.*

**Turn-pin.** A plug for stopping the flow from the open end of a pipe. A *tube-stopper*.

**Turn'plate.** A TURN-TABLE (which see).

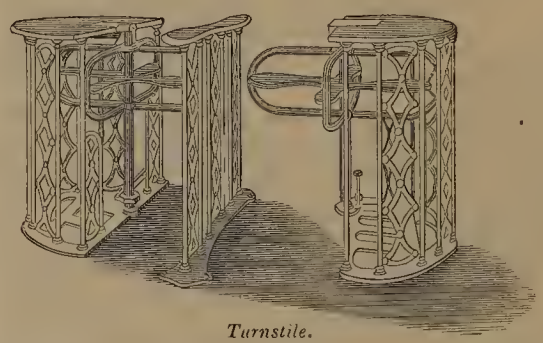
**Turn-screw.** 1. A screw-driver.

2. A screw-wrench.

**Turn'stile.** A post with four horizontal arms, which revolve as a person pushes by them.

Fig. 6808 is a self-registeriug turnstile, for toll-bridges or other places where fares are to be collected from foot passengers, or it is desired to ascertain their number. The upright shaft on which the stile turns actuates a train of gearing moving a series of indexes which point out the number of revolutions or partial revolutions made by the stile.

Fig. 6808.



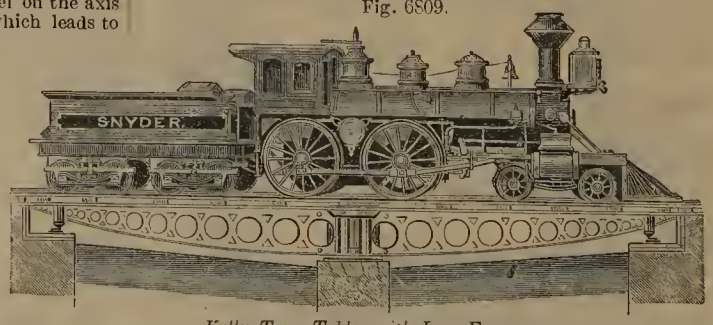
*Turnstile.*

The *groma* of the Romans was the board on a turnstile to show the direction of the ways in a camp.

**Turn'stile-count'er.** A turnstile-counter for omnibuses and cars is described in English patent No. 2189, of 1854. See previous and succeeding articles.

**Turn'stile-reg'is-ter.** A device for registering the number of persons who pass through a turnstile serving as the entrance to a toll-bridge or building, and serving as a check on the collector. The axis on which the stile turns is caused to rotate a series of gear-wheels which operate the indicator. The stile can only rotate in one direction, and has a lock-

Fig. 6809.

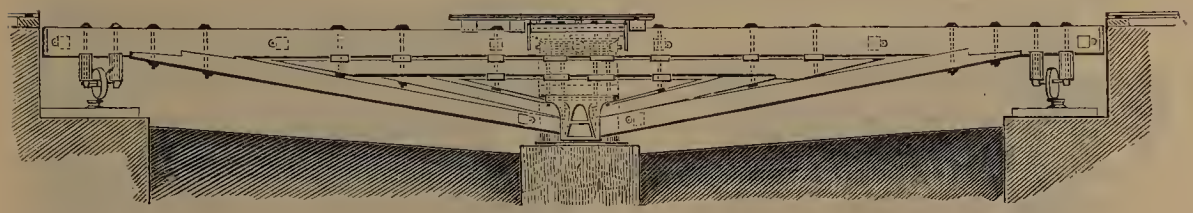



*Kelly Turn-Table, with Iron Frame.*

ing device controlled by a foot-lever, so that the collector may prevent the passage of more than one person at a time.

**Turn-ta'ble.** 1. (*Railway Engineering.*) A platform which rotates in a horizontal plane, and is used for shifting rolling stock from one line of rails to another. Devices common to all are the plat-

Fig. 6810.

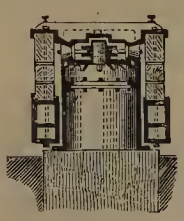


*Turn-Table, with Wooden Frame.*

form, which has one or more tracks of rails on its upper surface; rollers on which it turns, gearing for rotating it, a central pivot on which it rotates, a circular track on which the rollers move, and solid foundations for this track and for the central pivot.

Kelly's turn-table (Fig. 6809) is centrally supported on a series of frusto-conical rollers turning on arms radially projecting from a collar, which revolves around the axis of the table.

Fig. 6811.



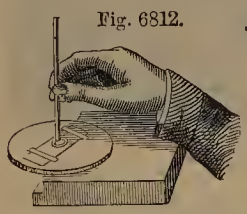
*Turn-Table.*

The apexes of the cones would, if they were complete, meet at a point in their axis. They are interposed between two annular castings correspondingly beveled, the lower of which is fixed, and serves as a track, and the upper is attached to and turns with the table. Flanges on the inner ends of the rollers prevent their being pushed outwardly by the pressure. In a modified arrangement small conical rollers turning between the large rollers and plates on the ends of the arms which carry them are substituted for the flanges. See also Figs. 6810, 6811.

Adams's turn-table (English) floats in a water-tank.

2. A device upon which a microscope slide is held for tracing the circular cement cells in which objects are placed for examination.

Fig. 6812.



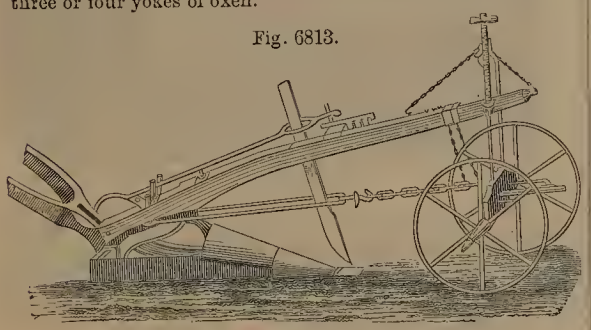
*Turn-Table.*

**Turn-tree.** (*Mining.*) A part of the drawing-*stowce* or windlass.

**Turn-wrest Plow.** (*Husbandry.*) *a.* An English plow of large size, and without a mold-board, adapted to be drawn by four horses and as many more as the farmer can spare. It burrows in the soil of the county (Kent), where it still maintains its hold upon the affections of the people, and is apparently prized on account of its lifting and tearing action in a soil which would be too much compacted by the pressure of a sole, land-side, and mold-board.

We should esteem it a regular horse-killer, and could use it nowhere but in grubbing, and then it should be drawn by three or four yokes of oxen.

Fig. 6813.



*Improved Kentish Turn-Wrest Plow.*

The name *turn-wrest* has clung to it for two and a half centuries, through all the scoffing and affected admiration it has excited, and means that the *wrest* or direction in which the soil is wrenched or pushed can be *turned* or changed. This is accomplished by shifting the colter to one side or the other, so as to divide the slice from the land; the *share*, burrowing beneath, then lifts the slice, which is farther displaced by the *breast* of the timber to whose end the share is attached.

This extraordinary and clumsy implement has a share which resembles, except in size, some of the ancient plows, and those still in use in countries where the schoolmaster, the steam-engine, and the printing-press have not effectually penetrated. See PLOW.

English agricultural authorities admit that "it is the ugliest, heaviest, and most cumbersome-looking machine to be found in all England."

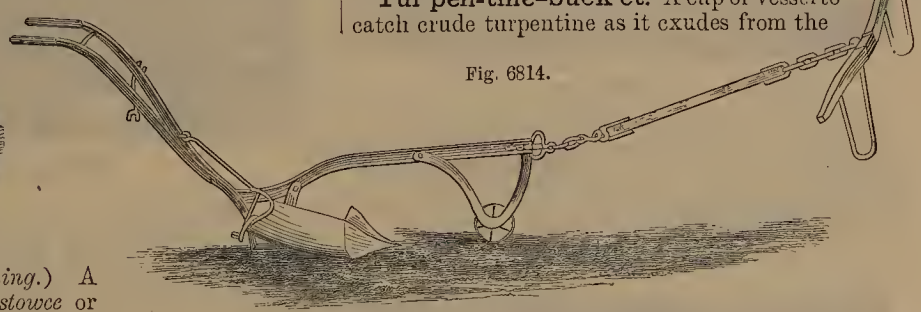
Boys, in his "Survey of Kent," gives a description of the implement.

*b.* A plow having a reversible share and colter so as to work both backward and forward and lay the furrows in the same direction.

The illustration shows a simple form adapted for light plowing on easy soils. A wing on the share acts as a colter, and at the end of the furrow the mold-board and share are turned under the frame of the plow, and at once fall into place for turning the next furrow against the previous one. See SIDEHILL PLOW, page 2173.

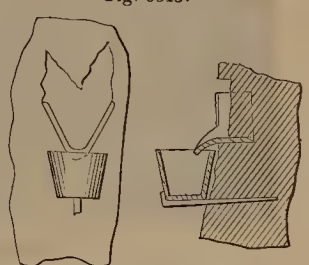
**Tur'pen-tine-buck'et.** A cup or vessel to catch crude turpentine as it exudes from the tree. In the example (Fig. 6815), the spout is made in a V-form, and is driven into the tree to form the bottom of the *boxing* chopped out to collect turpentine.

Fig. 6814.



*English Turn-Wrest Plow, made for India.*

Fig. 6815.



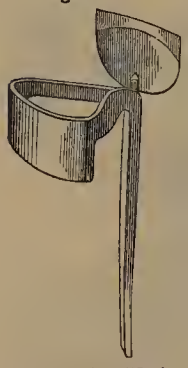
*Turpentine-Bucket.*

**Tur'pen-tine-hack.** A tool for barking and cutting pine-trees, to allow the crude turpentine to exude.

Fig. 6816 is a tool for either cutting or scraping, by upward or downward motion.

Ten thousand trees or *boxes* constitute a plantation. Each tree is cut at the bottom so as to form a box or receptacle, holding about a quart of crude turpentine. Each tree is partially stripped of bark, and every two weeks is cut higher up, always in the shape of a V, by a heavy long-handled implement, termed the *hack*. The V-cut prevents the edges from becoming hard and the turpentine from oozing out, the turpentine being guided to the lowest point of the V. The hands become very proficient in cutting and keeping open these V's. One man is able to cut 10,000 of the boxes in a week, some trees having three and four boxes. There are three crops and a scraping raised in a season, — say, 450 barrels, — the scrapings generally paying all the expenses attending the cutting and gathering. When the cutting

Fig. 6816.



*Turpentine-Hack.*

reaches an inconveniently high point, the tree is felled and used for timber or firewood.

The *hacking* operation, and the mode of hauling the filled barrels of tar to market, which is often effected in a manner similar to that formerly employed with tobacco hogsheads in Virginia, are shown in Figs. 6817, 6818. Both tar and turpentine are frequently rafted to the seaboard.

The *dipping* (Fig. 6819) is effected with a spoon-shaped instrument, the gum being collected in buckets, which are afterward emptied into barrels. The first year's produce is *virgin-dip*, the second *yellow-dip*, the third yellow-dip and *scrape;* after the third year, the product is all scrape. The virgin-dip is, when carefully gathered, a honey-like gum, of whitish appearance. From it are produced *No. 1, pale, extra*, and *window-glass* rosins. It yields about 7 gallons of spirits and somewhat less than ¾ of a barrel of rosin to the barrel of 280 lbs. *Yellow-dip* and *scrape* yield about 6 gallons of spirits and ¾ barrel of rosin to the barrel.

Fig. 6817.

*Hacking.*

*Scrape* is the gum which collects on the face of the box or barked portion of the tree, when it has been worked up 3 or 4 feet or more. It is a whitish, cheese-like substance. Fig. 6820 represents the operation of chipping the face; this is done with an implement termed the *round-share*. For removing the *scrape*, a somewhat similar tool, the *scraper*, is employed.

Fig. 6818.

*Hauling.*

The gum is distilled in copper stills, containing from 10 to 60 barrels; from 30 to 40 barrels is a usual size. They are bricked up at the sides, and the fire strikes directly upon their bottoms. The top has a large hole for the cap, which connects with the worm for condensing the spirits, and a small hole for enabling the stiller to watch the process and let in water, if required. The residual rosin is drawn off into vats and barreled. Fig. 6821 is a rear view of a distillery, showing the stills and rosin-vats.

In trees deadened by fire, old boxed trees left standing, and in stumps of trees cut while the sap is up, the pores become saturated with the gum. These are largely employed for making tar.

Fig. 6819.

*Dipping.*

For this purpose the wood is split into billets 3 or 4 feet long, and about 3 inches thick. These are laid radially around a central aperture, each tier projecting slightly beyond that below, the whole kiln forming a frustum of an inverted cone, as shown in Fig. 6822. The fire is kindled at the top of the kiln, and

Fig. 6820.

*Chipping the Face.*

the tar trickling downward into the opening is conducted by a spout to a suitable reservoir. See also CHARCOAL-FURNACE.

**Tur'pen-tine-still.** An apparatus for the distillation of turpentine from pine wood.

The blocks of wood are placed in retort *G* (Fig. 6823), the door on the right closed, the valve at the conical end closed, and the valve above opened. Water being introduced into the

Fig. 6821.

*Distilling.*

chambers to the level of the grate-bars, fire is applied, and the clear white spirit passes in vapor by the neck *V* to the worm in tub *C*. As soon as it begins to show color, the valve above is closed, and the valve at the conical end opened, when the vapor passes through the purifier *L* into the chamber, which is surrounded by water in tub *D*.

**Tur'rel.** A cooper's tool.

**Tur'ret.** 1. (*Architecture.*) A tower attached to a building, and extending above and beyond its general outline.

2. (*Fortification.*) The revolving tower for offensive purposes, on land or water, was invented by Theodore R. Timby, of Saratoga, N. Y. The idea was conceived and a model made in 1841, caveated in 1843, patented in 1862.

The tower of that time consisted of a cylindrical iron structure, having several tiers of casemates, and one barbette platform, all revolving together around a central tower which

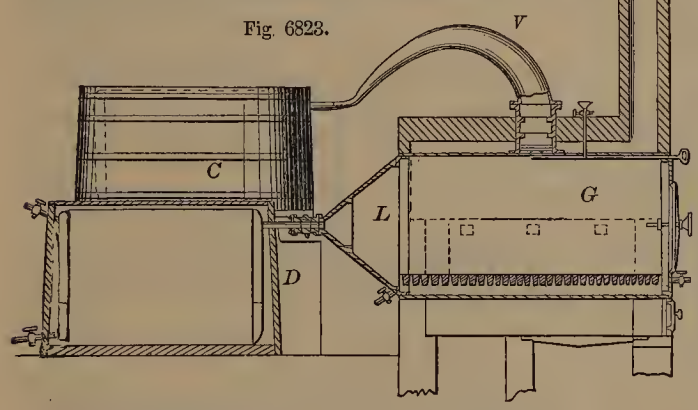
Fig. 6822.

*Tar-Kiln.*

forms the axis, the motor being a steam-engine. At the summit of the central tower is the lookout, which is capable of independent revolution when desired, and has a telescope mounted to sweep the horizon, and with altitude adjustments. Electric apparatus, under the control of the observer at the telescope, fires the guns, as, in their revolution, they come into range corresponding to that of the telescope above. The revolving tower is partially imbedded in a base, whose crowning story forms a stationary casemate-tower.

After a legal contest, involving the date and priority of invention, the claims were granted by the Patent Office, and it is understood that the United States government paid Mr. Timby a royalty upon all the monitors and revolving-turret vessels.

Fig. 6823.




*Apparatus for Extracting Spirits of Turpentine from Pine-Wood.*

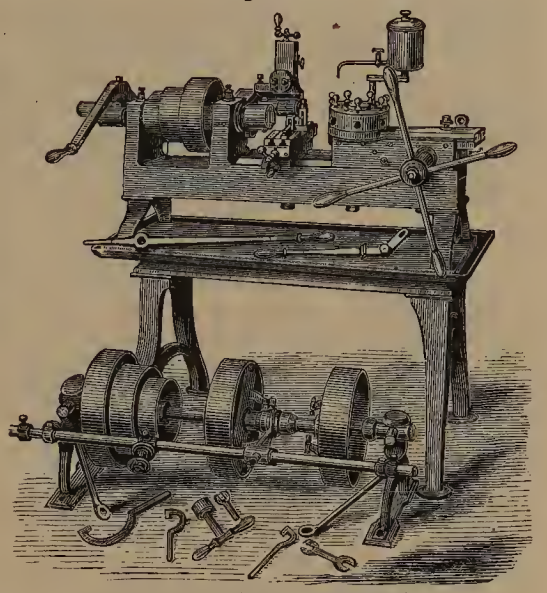
The turret adopted by Captain Ericsson in his monitors is constructed on the same general principle as that of Mr. Timby.

Between 1855 and 1860, Captain Cowper Coles, R. N., invented a form of turret for war-vessels, differing from the above in having but little elevation above the deck, resting upon rollers beneath the deck, and being turned by a hand-winch. See ARMOR-PLATING; IRON-CLAD.

It has been proposed to construct circular floating turrets, inclosed in tanks or wells; these may be either located on land or be buoyant structures in which the turret floats.

Two circular-turreted ships have been built by the Russian government. These are of iron, planked with wood, and sheathed with copper, 99.2 feet in diameter, and drawing 12.1 feet of water. The bottom is perfectly flat, and the sides are vertical, having an overhanging projection aft to protect the rudder. In order to insure stability, twelve keels, each about three inches in depth, are affixed to the bottom. The turret is fixed, is 29 feet 6 inches in diameter, and 7 feet high,

Fig. 6824.



*Brown and Sharpe's Turret-Lathe.*

and the gun platforms turn on a hollow axis, which serves as an ammunition scuttle, at the center of the ship, and contains two 11-ton guns, mounted *en barbette*, so as to fire over the top of the turret walls and admit of being trained to an angle of 30° or 35° on either side of a fore and aft line; the upper part of the hull and the turret are plated with 9-inch armor. These vessels are driven by six screws, operated by as many as 80 horse-power engines, and one of them has attained a speed of six knots an hour, and has been turned in 1 minute and 19 seconds.

3. (*Railway.*) The elevated central portion of a passenger-car, whose top forms an upper story of the roof, and whose sides are glazed for light and pierced for ventilation.

**Tur'ret-clock.** One adapted for an elevated position in a church or other tower.

**Tur'ret-gun.** One specially adapted for use in revolving turrets of vessels.

**Tur'ret-lathe.** (*Metal-working.*) A screw-cutting lathe having a slide provided with a polygonal block or *turret*, having apertures in each face for receiving dies which are secured therein by set-screws.

The rod of metal to be threaded is inserted in the hollow mandrel of the spindle, and the threads are cut successively deeper by the dies on the different sides of the turret, which is partially rotated for this purpose after each cut. The slide has automatic feeding arrangements, but may be advanced by hand. A cutter on a hand side-rest serves to sever bolts to the required lengths after the thread is cut, and they are dropped into a receptacle below. Nuts can be drilled, tapped, and one side faced up, and many parts of sewing-machines, cottou machinery, gas and steam fittings, made on this machine, with a great saving of time and labor. Size of hole through spindle, 1¼ inches. Size of holes in revolving head, 1 1/16 inch. Length that can be milled, 6 inches. Friction-pulleys on counter-shaft are 14 inches diameter and 3½ inches wide. Counter-shaft should run 170 turns per minute. Weight of machine prepared for shipment, about 1,450 pounds.

**Tur'ret-ship.** A ship whose armament is placed in a tower or turret which is capable of revolution, so as to bring the embrasure opposite to the gun, which is pointed in any direction and temporarily unmasked while firing.

Sometimes the revolving turret projects through the deck of an iron-plated war-vessel. Invented by Timby, of New York. Captain Coles, of England, made some changes in the adaptation of the turret to the hull. See TURRET.

**Turs'kil.** The Scotch paring-spade. *Tuskar.*

**Tur'tle.** (*Printing.*) The segmental plate in which a *form* is *locked* up, in a cylinder press.

The column-rules are wider at top than at bottom, to hold the type firmly, and are secured by screws. The edge of the side-stick has a series of beveled projections, and is pressed against the form by a piece having similarly beveled projections and operated by a screw.

**Tusk.** 1. Formerly applied to the share of a plow.

> "That shortly plow or harrow
> Shall pass o'er what was Ismail, and its *tusk*
> Be unimpeded by the proudest mosque." — *Don Juan.*

2. (*Locksmithing.*) A sharp projecting point or claw which forms a means of engagement or attachment. Used in the parts of locks in which bolts, tumblers, etc., are thus provided so as to be touched, dropped, raised, etc., by the key, directly or by intermediate devices.

3. (*Carpentry.*) The beveled shoulder on the back of a tenon of a binding joist, to strengthen it.

**Tus'sah-silk.** A strong, coarse, dark silk, made from a native Bengal silk-worm.

**Tu-ta'ni-a.** (*Alloy.*) A white alloy for tableware, etc. German: copper, 1; tin, 48; antimony, 4. Spanish: steel, 1; tin, 24; antimony, 2. See ALLOY.

**Tu'te-nag.** 1. (*Alloy.*) A white alloy of copper, 50; nickel, 19; and zinc, 31, used for tableware, etc. It resembles Packfong, Chinese white copper, albata, German silver. The alloy has various names and proportions of the ingredients; a small quantity of lead or iron is added in some formulas. See WHITE-METAL ALLOYS, table, page 63.

2. Zinc or spelter.

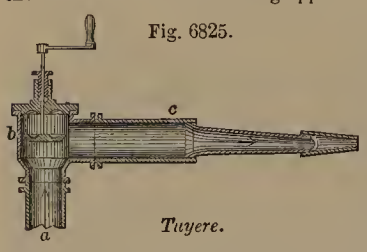
**Tut'ty.** An impure protoxide of zinc, used as a polishing powder.

**Tut-work.** (*Mining.*) Work done in the non-metalliferous rock for the purpose of discovery, in the excavation of shafts, drifts, adits, etc. Also called *dead-work.*

**Tuy-ere'.** 1. (*Metallurgy.*) A tube having a conical end, with its appurtenances for regulating and directing a current of air upon the metal in a smelting furnace or forge.

In Fig. 6825, *a* is the pipe through which air is received from the wind-chest of the blowing-apparatus; a valve *b*, operated by a handle, governs the amount admitted to the tube *c*, the conical end of which enters a corresponding aperture in the lower part of the furnace. Usually two or three tuyeres are so arranged that their blasts are converged toward the center of the furnace. When but two are employed, they are placed at opposite sides, but the *nose-pipe* of each is so directed as to give a little inclination to the air-jet, that the currents may not interfere with each other.

Fig. 6825.




*Tuyere.*

In blast and cupola furnaces, but especially the latter, a number of tuyeres have been employed, arranged in vertical series, as shown in Fig. 6826. See also CUPOLA-FURNACE.

In Fig. 6826, the area of the blast openings of the tuyeres decreases toward the upper portion of the series, and their mouths are protected by pillars of fire-brick.

Pevy's cupola-furnace has a wind-chest around the furnace, from whence the tuyeres are supplied.

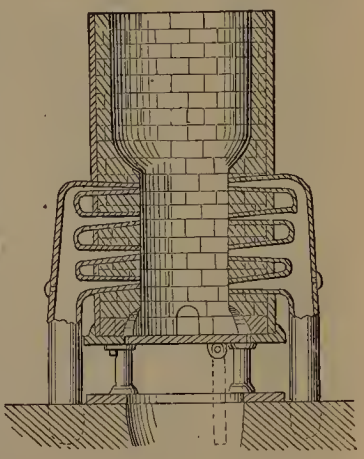
Truesdale's cupola-furnace has circular rows of tuyeres around the chamber, arranged in several tiers. The blast-openings decrease in area in the several tiers from the upper to the lower.

The tuyeres of the Bessemer convertor are perforated blocks of fire-brick set in the floor of the retort, and affording passage for the air into the mass of liquid metal above. See BESSEMER; CONVERTOR; STEEL.

The blast-pipe of the forge or furnace is sometimes cooled by passing through a casing around which a current of water is caused to pass. Such an arrangement is called a *water-tuyere.*

Wm. Barker's United States patent, November 10, 1818, for a water tew-iron, is the first instance of a *water-tuyere* known to the writer.

Fig. 6826.



*Cupola-Furnace.*

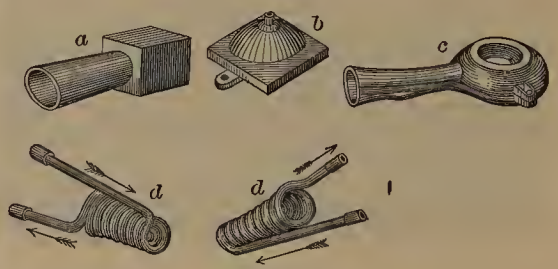
"An external covering or case of metal passing round the common tew-iron and forming a chamber into which a continual supply of water is introduced; whereby water keeps the tew-iron cool, and prevents it from burning." One pipe conveys in the water, and another carries away the steam. Where water is abundant, a stream is run continually through it.

In Mackenzie and Isbell's cupola-furnace, separate blast-chambers are arranged in a vertical series around the cupola, receive air by valved branch-pipes from the main, and communicate by distinct rows of tuyeres with the interior.

Tuyeres in different positions around the furnace, and at different elevations, are described in Howell's United States patent for making malleable iron direct from the ore.

*a*, negro-head tuyere.
*b*, bull's-eye tuyere.
*c*, duck's-nest tuyere.
*d* are the air-supply pipes for the tuyeres of a hot-blast furnace. They are convoluted, so that the air in its passage through them is longer exposed to the action of the fire, and becomes more thoroughly heated.

Fig. 6827.




*Forge-Tuyeres.*

**Tweed.** (*Fabric.*) A light, twilled woolen fabric for men's wear, with an unfinished surface. Two colors are generally combined in the same yarn. The best is made all of wool, but in inferior kinds shoddy and cotton are also introduced.

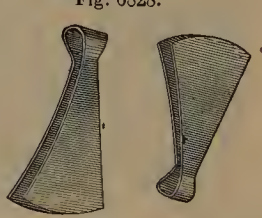
The name is said to have originated in a mistake in spelling; the word *tweed* having been substituted for *tweel* in an invoice, the consignee took advantage of the fact to put forth the goods as a new kind of fabric.

**Tweer.** A *tuyere*, or blast-pipe of a furnace or forge. See TUYERE.

**Tweeze.** (From Fr., *Etuis*, pl. A case for small articles.) A surgeon's case of instruments.

**Twee'zers.** 1. A delicate kind of pinchers with two fingers, adapted for grasping hairs. Used among almost all nations, especially among those who eradicate the beard.

Fig. 6828.



*Peruvian Tweezers of Copper.*

The Roman *volsellæ;* used in eradicating hair. A small pair made of ivory has been found in a British barrow.

The cut shows Peruvian tweezers, of copper.

Tweezers of copper have also been disinterred at Pompeii, and are now in the museum at Portici.

"And there bought me a pair of tweezers, cost me 14 *s.*" — PEPYS, 1662.

2. A surgeon's case of instruments. See TWEEZE.

**Twelfth.** (*Music.*) A stop of an organ tuned one twelfth above *open diapason.* See STOP.

**Twelve'mo.** (*Printing.*) A sheet which folds into 12 leaves or 24 pages. Otherwise called duodecimo, and written 12mo.

**Twen'ty-fours.** (*Printing.*) A sheet adapted to be folded into 24 leaves, 48 pages. Otherwise written 24mo.

**Twi'bill.** 1. A mattock. The blade has one end like an axe, the other like an adze.

2. A mortising-tool.

3. A reaping-hook.

**Twill.** 1. Or *tweel.* A diagonal appearance given to a fabric by causing the weft-threads to pass over one warp thread, and then under two, and so on; instead of taking the warp-threads in regular succession, one down and one up. The next weft-thread takes a set oblique to the former, throwing up one of the two deposed by the preceding. The diagram will make the plan understood. In some twills it is one and three, or one and four.

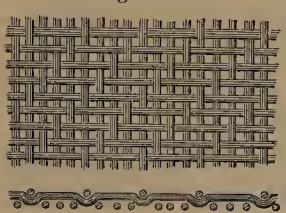
The Latin *trilix*, a certain pattern in weaving, became *drillich* in German, and hence our word *drill.*

*Twill* is derived from *zwillich*, which answers to the Latin *bilix*, and Greek *dimitos.* The latter survives in *dimity.* See also SAMITE, derived from ἑξάμιτος, six-leaved.

The French *touaille* has also been suggested as the etymological source of the word.

The fabrics thus woven are very numerous,—*satin*, *blanket*, *merino*, *bombazeen*, *kerseymere*, etc. When the threads cross each alternately, in regular order, it is called *plain weaving;* but in *twill*, the same thread of weft is *flushed*, or separated from the warp, while passing over a number of warp-threads, and then passes under a warp-thread. The points where the threads of the warp cross form diagonal lines, parallel to each other, across the face of the cloth. In *blanket twill* every third thread is crossed. In some fabrics 4, 5, 6, 7, or 8 threads are crossed. In *full satin twill* there is an interval of 15 threads, the warp (*organzine* silk) being floated over 15 threads of the woof (*tram*), giving the glossy appearance.

Fig. 6829.



*Four-Leaved Twilled Weaving.*

Twills require heddles equal in number to the threads that are included in the intervals between the intersections. This disposition of the warps in the heddles is termed *mounting the loom;* and the heddles are termed *leaves.* A twill takes its name from the number of *leaves* employed, as a *three-leaf twill*, a *five-leaf twill*, etc.

Twills are used for the display of color, for strength, variety, thickness, or durability.

"The generic difference of twilling, when compared with common cloth, consists in the intersections, although uniform and equidistant, being, at determinate intervals, greater than between the alternate threads. Hence we have specimens of twilled cloths where the intersections take place at the 3d, 4th, 5th, 6th, 7th, 8th, and 16th intervals only. The threads, thus deflecting only at intervals from a straight line, preserve more of their original direction, and a much greater quantity of materials can be combined in an equal space than in the alternate intersection, where the tortuous deflection, at every interval, keeps them more asunder. On this principle, twilled cloths, of 3 and 4 leaves, are woven for facility of combination alone. The coarser species of ornamental cloths, known by the names of *dornock* or *diaper*, usually intersect at the 5th or half-satin interval. The 6th and 7th are rarely used, and the 8th is distinguished by the name of *satin*, in common, and of *damask*, in ornamental, twilling."—URE. These are varieties known as *broken*, *biassed*, *regular.*

2. The fabric so made.

Twilled cloth has several advantages: —

1. The materials may be put more closely together.

2. Its susceptibility for receiving ornament, being capable of being inverted at pleasure.

For a statement more at length, see "Ure's Dictionary," II. pp. 821-826.

3. A quill or spool for winding thread.

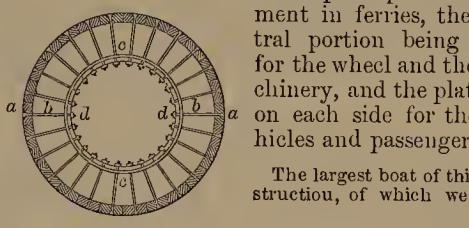
**Twil'ly.** A willowing-machine. A form of cotton-cleaner. In the coarse Lancashire style a *twilly-devil.*

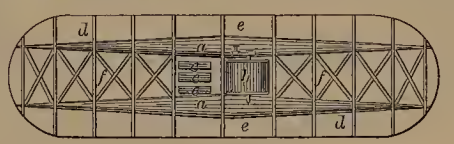
**Twin-boat.** A boat or deck supported on two parallel floating bodies, which are placed some distance asunder. The floats are usually long, pointed at each end, and circular in cross section. They are called *spindle* or *cigar shaped.*

The object of the construction is stability and speed, the former being secured by the lateral extension, and the latter by diminished submerged section. The wheel is usually in the space between the spindles.

The idea may be founded upon the outrigger boats of the Indies, or upon some form of raft.

Fig. 6830.




*Twin-Boat.*

Twin-boats have found their principal employment in ferries, the central portion being used for the wheel and the machinery, and the platform on each side for the vehicles and passengers.

The largest boat of this construction, of which we have seen any mention, was a vessel constructed to run on the Hudson River. The spindles were 300 feet long, and in the center, or thickest part, were 8 feet in diameter, tapering in a regular parabolic curve to a point at each end. The paddle-wheel, which was 30 feet in diameter, worked in the space between the spindles.

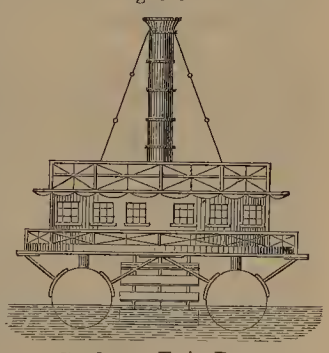
In the sectional view, *a a* are the staves, 26 in number and 3½ inches thick, to each of which is attached an iron bolt, *b b*, 26 inches long, passing through the staves, and countersunk on the outside of them. These bolts pass through an iron ring *c*, on the inside of which they are screwed up by nuts *d d*; sufficient room is left in the center for a man to enter and pass fore and aft, to examine the bolts.

In the plan, *a a* are the spindles; *b*, the paddle-wheel; *c c c*, the boilers; *d d*, the cross-beams, which cross the spindles, and reach to the outside yards; *e e*, *f f*, the diagonal bracing.

This vessel was built at New York for a Hudson River passenger-boat. She was said to have run 21 miles in 61 minutes, to have averaged on the river 20 miles per hour, and 14 miles per hour at sea. Her draft of water was 24 inches. She was wrecked after making a few trips.

Snodgrass twin-boat, English patent, 1837. The spindles are of sheet-iron, and are cylindrical for the middle one-third portion of their length. They are divided into apartments, by bulk-heads, which divide each spindle into air and water tight sections. Longitudinal beams and transverse braces supported the platform, or deck, upon which the boilers, engines, and cabin accommodations were placed. The single wheel rotated in the interval between the spindles.

Fig. 6831.



*Snodgrass Twin-Boat.*

Gemmell's patent, about the same time, had exterior side-wheels.

Symington's steam-boats, 1789-1802, were twin-boats, in which the single paddle-wheel was revolved in the central space.

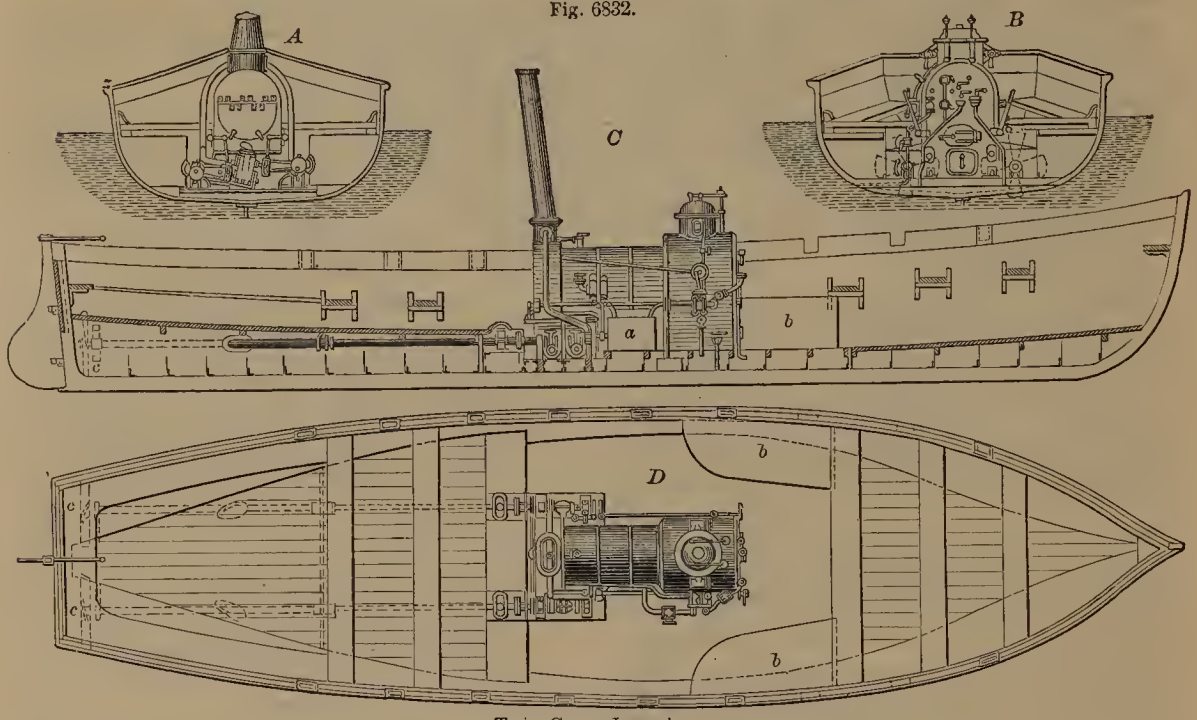
A large twin channel steamer, the "Castalia," has lately been put upon the Dover and Calais ferry, Europe. Each hull is 234 feet long, 16.4 beam, 12.6 hold; distance between hulls, 25.2. She has paddle-wheels between the hulls, each driven by its own engine.

**Twine.** A strong hempen thread used in sewing sails.

Sewing-twine for sails weighs at the rate of 360 to 430 fathoms to the pound.

One pound of twine will sew 160 yards of seam, on an average.

Fig. 6832.




*Twin-Screw Launch.*

Fig. 6833.

*Twine-Holder.*

**Twine-cut'ter.** A blade or knife on a table, stand, or counter, to cut twine when tying packages.

**Twine-hold'er.** A box or case to hold a ball of twine on a counter.

**Twine-ma-chine'.** A spinning-machine for small hempen or cotton string. A *thread-machine.*

**Twine-reel'er.** A *mule-doubler.*

**Twin'ning-ma-chine'.** A machine for cutting two combs (twins) from the single piece. It is said to have been invented by Mr. Thomas of Philadelphia. The cutter consists of two chisels which act perpendicularly and alternately upon the plate which passes beneath them. Each chisel cuts one side of two teeth, and severs one from the opposite back at each stroke. See COMB.

**Twin'ning-saw.** A saw for cutting the teeth of combs. It is so called because the material is bent over to render the cut surface convex, two combs (twins) being cut from one piece. The point of each tooth is cut from the back of the opposite comb by means of an instrument called a *plugging-awl.*

**Twin-pow'er Press.** One in which the power is brought upon two objects in alternation, as in some machines where the punch and shears are in the same frame. See under those heads.

**Twin-screws.** A pair of screw-propellers on separate shaft, and having *right-handed* and *left-handed* twists respectively. Being turned in contrary directions in driving ahead, they counteract each other's tendencies to produce lateral vibration.

The shafts of the twin screws are sometimes made to pass through the ship's skin at suitable points in the after part of the bottom, and supported at their after ends by iron buckets; and sometimes they are contained in a pair of twin stern-posts and twin runs, the ship being so designed as to have a single fore-body and a double after-body.

Twin-screws were used upon the earliest practical propeller steamboat, that of Colonel John Stevens of Hoboken, 1804. See SCREW-PROPELLER, page 2071, Fig. 4747.

Twin-screws are used also upon some of the Winan's cigar-steamers, the third and the fourth of the series. See page 553.

Fig. 6832 illustrates a steam-launch with twin-screw propellers.

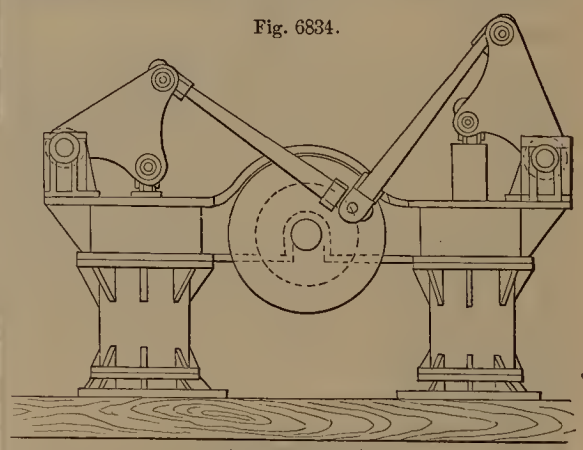
*A*, transverse section looking forward.
*B*, transverse section looking aft.
*C*, longitudinal sectional elevation.
*D*, plan.
*a*, feed-water tank.
*b*, coal-boxes.
*c*, twin-screws.

**Twin Steam-en'gine.** Another name for a duplex engine; one in which two engines, complete in their parts, are associated in a single effort.

Numerous instances occur in practice where the name might be correctly applied.

Fig. 6834 is one form in which two vertical cylinders with an entablature resting upon them as upon columns, by which means the cylinders and entablature constitute the principal frame of the engine, and give access to the cylinder-heads through apertures in the entablature. The main crank is located in the center of the entablature, and both pistons are connected to the same crank.

Fig. 6834.

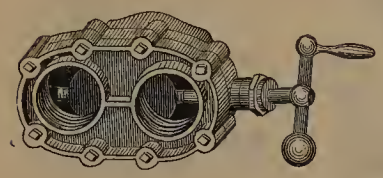


*Twin Steam-Engine.*

**Twin-valve.** A form of valve attached to the discharge outlet of a pump. It is used for making a double connection, one with the steam-boiler, for supplying it with water, and the other with a line of hose, for use in case of fire, or for conducting water wherever desired.

**Twist.** 1. (*Small-arms.*) A mode of construction of gun-barrels in which the iron, in the form of a ribbon, is heated and coiled spirally around a mandrel. The spiral is then raised to a welding heat and dropped upon an iron rod, which is *jumped;* that is, struck forcibly and vertically upon an anvil, which causes the edges of the spiral to adhere. The welding is finished on an anvil, the mandrel retaining its position inside.

Fig. 6835.



*Twin-Valve.*

The ribbon of iron is several yards long and about half an inch wide, varying in thickness from the thick or breech end of the barrel to the thin or muzzle end.

Fig. 6836.

*Twisted Barrel.*

Various kinds of ribbons are made. Those from horseshoe nails and steel are called *stub-twist.* A certain laminated iron and steel is known as *wire-twist.*

A laminated iron and mild steel, laid parallel in ribbons, welded, then twisted at one end while the other is held in a vise, combined in a fagot with another or others twisted in a diverse direction, rolled, and drawn into ribbons, is a *Damascus-twist.* See GUN-BARREL.

2. (*Guns and Ordnance.*) The spiral in the bore of a rifled gun. It is spoken of as a ¾ twist, etc., as it completes that much, more or less, of a revolution in the length of the barrel.

An *increase* or *gaining* twist is one in which the spiral inclination of the grooves becomes more rapid toward the muzzle. Invented by Tamisier.

Another mode of designating the twist is in the length required to complete a revolution, which is usually considerably in excess of the length of the barrel.

3. (*Architecture.*) The wind of the bed-joint of each course of voussoirs in a skew arch.

4. (*Weaving.*) The *warp*-thread of the *web.* Also known as the *filling,* or *chain.*

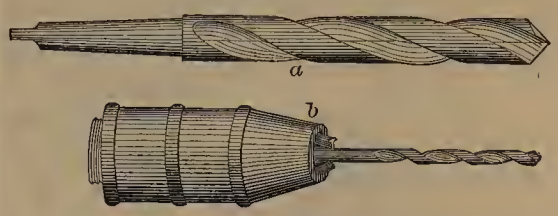
5. A kind of cotton yarn.

6. A closely twisted strong sewing-silk. Saddler's silk.

**Twist-drill.** (*Metal-working.*) A drill having a twisted body like that of an auger. The advantages claimed for such drills are that they serve as guides to keep the hole true, that they work at the proper cutting angle, and are tempered throughout their working length, and that they do not require re-dressing to maintain a uniform size.

In making them, a bar of steel is rolled to a special shape, cut into length, and again rolled in cam rolls, which form a straight groove, after which the shank is formed. The blank is then twisted by means of a machine, where one end is received in a hollow nut at the end of a perforated spindle, which has a rotary and longitudinal movement, the other end being held by vise-clamps. After twisting, the drill is centered and rough ground, hardened by heating in a lead bath and cooling in water, tempered in an oil bath, and finally finished by grinding to a standard gage.

Fig. 6837.




*Twist Drills and Chuck.*

**Twist-drill Grind'er.** One specifically adapted for giving an accurate chisel-point to a twist-drill, the cutting edges being inclined at similar angles.

**Twist'ed Bit.** 1. (*Manege.*) One having a mouthpiece made with square sides and afterward twisted.

2. (*Carpentry.*) A wood-boring tool adapted to be used in a brace. It is a form of flat bar twisted into a spiral form and provided at the ends with a cutter and a routing-table. See BIT.

**Twist'ed Mouth.** (*Manege.*) A bit whose mouthpiece has been twisted, to make it more severe than it otherwise would be.

**Twist'er.** 1. A reel used in twisting yarns or threads.

2. A girder.

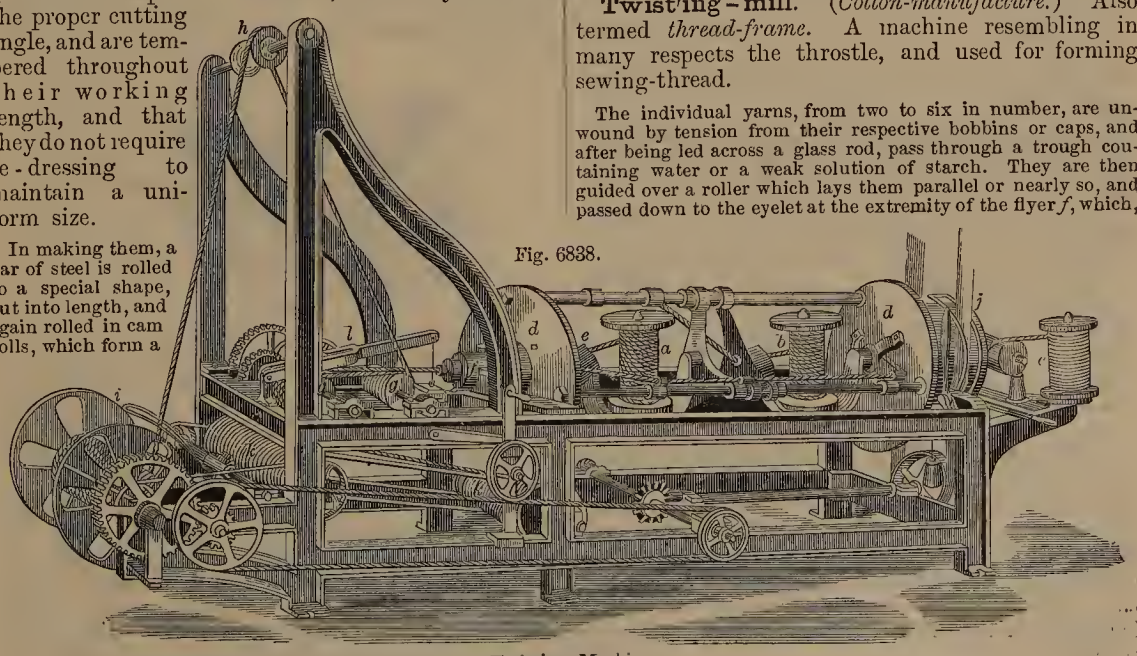
**Twist'ing-ma-chine'.** A machine for twisting and laying rope and cordage (Fig. 6838).

The strands are wound upon spools *a b c,* and are led through eyes along the revolving frame *d d,* and, meeting at the top *e,* are conducted through the hollow axis *f* of the frame, and after passing several times around the tension-rollers *g g,* the twisted rope is finally carried over an elevated roller *h* and wound upon the reel *i.* The rotary motion of the twisting-frame *d d* is derived from a belt and pulley *j* independent of the device by which the motion of translation is imparted. The velocity with which the rope is advanced and wound upon the reel *i* is governed by cone-pulleys *k k,* and is varied to impart a greater or less twist with a uniform rotary movement of the frame *d d. l* is a brake for checking and equalizing the motion of the tension-rollers. See ROPE-MACHINE.

**Twist'ing-mill.** (*Cotton-manufacture.*) Also termed *thread-frame.* A machine resembling in many respects the throstle, and used for forming sewing-thread.

The individual yarns, from two to six in number, are unwound by tension from their respective bobbins or caps, and after being led across a glass rod, pass through a trough containing water or a weak solution of starch. They are then guided over a roller which lays them parallel or nearly so, and passed down to the eyelet at the extremity of the flyer *f,* which,

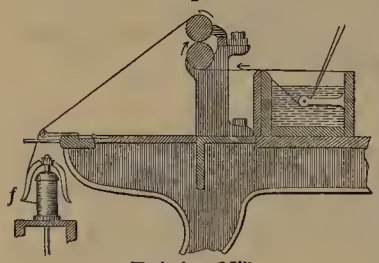
Fig. 6838.




*Twisting-Machine.*

by its rapid rotation, twists them into a solid cord or thread, which is wound upon the bobbin. The twist of the thread is usually in a reverse direction to that of the separate yarns. The topping rail on which the bobbins are placed has an up-and-down motion to cause an equal distribution of the thread on the bobbins.

Fig. 6839.



*Twisting-Mill.*

**Twist-ma-chine'.** One form of lace-making machine.

**Twitch.** A noose attached to a stock or handle and twisted around the upper lip of a horse, so as to bring him under command when shoeing. See BARNACLES.

**Twit'ter-bit.** The bottom of the countersink which receives the head of the screw, uniting the halves of a pair of scissors.

**Two-box Loom.** (*Weaving.*) One having two boxes for as many shuttles carrying differently colored yarns.

**Two-deck'er.** (*Nautical.*) A vessel of war carrying guns on two decks.

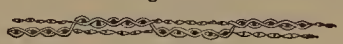
**Two-hand'ed Saw.** A whip-saw used in getting out ship-timbers. It has a handle at each end, one for each man.

**Two-line Let'ters.** (*Printing.*) Capitals which are equal to two bodies of any specific size of type, as *two-line pearl*, *two-line brevier*, etc. Used for lines in title-pages, the large letters at the beginning of advertisements, etc.

**Two-ply.** Woven double. See TWO-PLY CARPET.

**Two-ply Car'pet.** A carpet having a double web. Each web has its warp and its weft; but as

Fig. 6840.



*Double Cloth.*

these are interchangeable, a great variety of colors may be produced on either surface. One of the warps is alternately raised above the other while the shuttle is thrown. A section of this fabric is shown in Fig. 6840.

These carpets are wholly of worsted or of woolen; or the chain is of worsted and the weft of wool. (Worsted is a well-twisted yarn, made of long-stapled, combed wool.)

The process of weaving both webs is carried on at the same time, and in each part of the cloth that part is brought to the surface which is required to produce that portion of the pattern.

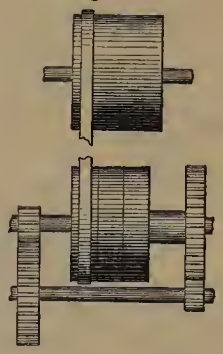
The warps are of different colors, and the threads are governed by treadles or by the Jacquard arrangement. The latter has generally superseded the less perfect contrivances, such as the *treadle*, *barrel*, or *draw looms*. The back of the carpet has the same pattern as the front, but the colors are reversed.

This form of carpet is known as *Scotch*, from its being so extensively manufactured in that country; also *kidderminster*, from the town of that name; also *ingrain*, from its being *dyed in the grain*, or before manufacture.

An extension of the same idea, in which three webs are interchangeably united, is known as *three-ply* or *triple-ingrain* carpet.

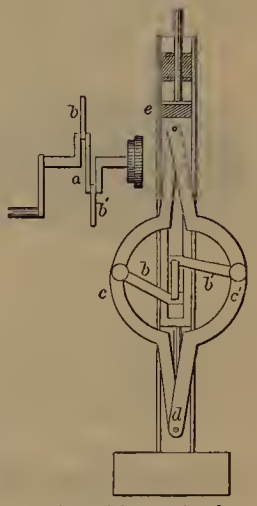
**Two-speed Pul'ley.** A variable speed arrangement consisting of two fast pulleys, the shaft of one being tubular and sleeved upon that of the other. One connects by large and small wheels to the lower shaft, and the other by small and large wheels, the difference in communicated speed being very apparent, and the belt being shifted from the loose pulley to one or the other of the fast pulleys, as may be required.

Fig. 6841.



*Two-Speed Pulley.*

Fig. 6842.

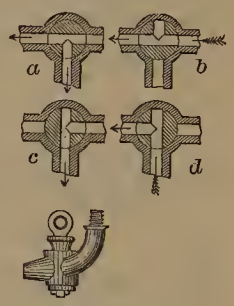



*Two-Throw Crank.*

**Two-throw Crank.** A device for converting circular into rectilinear reciprocating motion, or *vice versa*. In Fig. 6842, the crank *a*, rotated in any suitable way, has two levers *b b'*, one connected to each wrist, their other extremities being jointed to the curved rods *c c'*, which have a common fixed pivot *d* and are connected to the plunger *e*. The rotation of the crank causes an alternate approach and recession of the rods, imparting a reciprocating motion to the plunger and its connecting rod.

**Two-top'sail Schoon'er.** One carrying a square foresail and square foretopsail.

Fig. 6843.




*Two-Way Cock.*

**Two-way Cock.** By the two-way cock the water may be distributed to each of two branches, to either of them separately, or be entirely shut off.

*a* shows the water passing to each branch pipe.
*b*, the water passing to the direct branch only.
*c*, the water passing to the lateral branch only.
*d*, the water shut off.

For large stop-cocks for water-mains, see STOP-VALVE. For small ones, see STEAM-VALVE; STOP-VALVE; GLOBE-VALVE; etc.

**Two-wheeled Bar'row.** A sort of truck. See Fig. 6844.

Fig. 6844.

*Two-Wheeled Barrow.*

**Twy-ere'.** A TUYERE (which see).

**Tye.** 1. (*Nautical.*) A rope by which a yard is hoisted. It passes through the mast; one end is attached to the middle of the yard, and the other end is hooked to a purchase composed of the tye-block and fly-block, by which the hoisting is effected.

2. (*Mining.*) An inclined trough for separating ore by means of a flowing stream of water. The slimes are allowed to flow in a thin wide stream upon the upper part of the trough, are disturbed by a broom, and collected, according to relative weight and quality, at different parts of the length of the trough. The sorts are known as *heads*, *middles*, and

*tails;* the first going to *pile*, the second is *re-tyed*, the third is refuse.

**Tye-block.** (*Nautical.*) An iron-bound swiveled block, bolted into an eye in the hoop round the yard; through it the tye for hoisting the yard is rove.

**Ty'ing.** An operation on tin or copper ores resembling *buddling*, in which the ore is spread on an inclined bed and subjected to the action of running water. The ore is agitated with a broom or shovel, and the operation depends upon the superior weight of the particles which are richest in metal. The lighter portions travel farthest on the plane and are rejected, while the heavier are collected and smelted.

*Buddling*, *tying*, *trunking*, *chimming*, and *tossing* depend upon the agitation of the ore in the vessel. In *rocking*, *dilluing*, *jigging*, *framing*, or *racking*, the vessel itself is agitated. In all of them agitation in water is the effective action.

**Tym'bal.** (*Music.*) A kind of kettle-drum.

**Tymp.** (*Metallurgy.*) A space in the bottom of a blast-furnace, adjoining the crucible. See TYMPPLATE; BLAST-FURNACE.

**Tym'pan.** 1. (*Printing.*) A rectangular frame hinged by one edge to the carriage of a printing-press, and having stretched across it a piece of cloth or parchment. The blank sheets are laid upon the tympan, in order to be brought down upon the form to receive the impression.

The blank sheet is fitted upon the *tympan-sheet*, which is of the same size as the paper to be printed, and forms a guide for placing it.

The blank sheet is held by the *frisket*. See PRINTING-PRESS.

The *inner tympan* is a smaller canvassed frame, and the two *tympans* hold the blanket between them.

2. (*Architecture.*) A triangular space or table in the corners or sides of an arch, usually hollowed, and enriched with branches of laurel, olive, oak, etc., and sometimes with emblematical figures.

3. (*Music.*) The kettle-drum.

**Tym'pa-no.** (*Music.*) A kettle-drum. See TYMPAN.

**Tym'pan-sheet.** (*Printing.*) A sheet of paper like that to be printed, laid on the tympan as a guide for position in placing the sheets to be printed.

**Tym'pa-num.** 1. (*Hydraulic Engineering.*) An ancient form of wheel for elevating water. Its original form was like that of a drum, whence its name. It was a cylinder with radial partitions and small openings in the periphery, which admitted a certain quantity of water into the chambers thus formed as those portions of the periphery came in turn to be submerged. As the wheel revolved, such portions of water were carried up and flowed along the partition toward the axis around which the water was discharged, being elevated to a hight nearly equal to the radius of the wheel. The wheel was driven by floats on the periphery or side of the wheel, or by means of animal or manual power, and had several modifications.

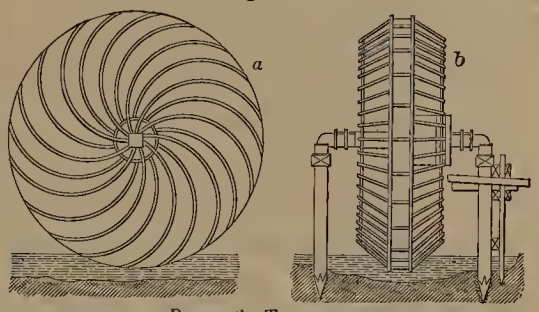
The Roman form of the *tympanum* is described by Vitruvius, 50 B. C., and was derived from Egypt. The partitions were 8 in number, and were radial; the holes, 6 inches in diameter, were made in the drum-like, cylindrical surface, which was otherwise closely boarded up; the wheel was mounted so as to rotate over the side of a vessel which was moored, and was driven by a *tread-wheel* on board the vessel; the water lifted by the buckets was discharged at the axis of the wheel. What is known as De la Faye's pump is constructed on this plan.

This wheel is often called the *Persian*, and this may be correct, geographically speaking; but for perspicuity, the term *Persian* should be applied to a wheel with boxes, pots, or buckets which are attached to the wheel, on or near its periphery. The *Noria* wheel of Palestine is, perhaps, a true example of the *Persian* wheel. See NORIA.

In process of time this highly useful wheel, so much used in Oriental countries in raising water for irrigation, was improved by removing the exterior surface from which it derived its name, the buckets being made scoop-shaped.

Such was the form used by Perronet, at Orleans Bridge, about 1750. In Fig. 6845, *a* is a section, and *b* an end elevation of this

Fig. 6845.




*Perronet's Tympanum.*

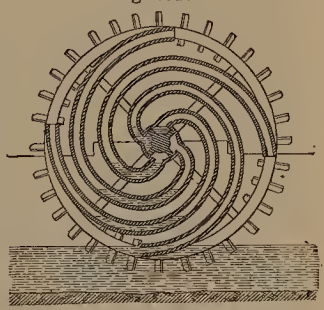
wheel. It had curved buckets, and raised the water 8 feet. Its effectiveness varied with the depth to which its circumference dipped into the water. At 1 foot submergence, 12 men, relieved every 2 hours, gave 2 turns per minute; at each turn, 24 cells were emptied, each containing 1½ cubic feet, giving, for the hour, 4,320 cubic feet of water raised 8 feet high; this was conveyed by the spiral buckets to an annular discharge-chamber around the axis of the wheel.

The comparison of effectiveness was as follows: —

| Submergence. | Revolution per hour. | Cubic feet raised. |
|---|---|---|
| 12 inches. | 120 | 4,320 |
| 9 inches. | 150 | 3,600 |
| 6 inches. | 180 | 2,880 |
| 3 inches. | 180 | 2,160 |

A modification of the tympanum has spiral ducts leading to a discharge-chamber around the axis. It is, or may be, propelled by the current.

Fig. 6846.



*Tympanum.*

This form of wheel has its advocates in all civilized countries, and is employed in draining some of the fluviatile districts in our Western country; for instance, at Cairo, where a wheel of this character is, or was, driven by steam-power, for removing the drainage of that rather low site, discharging it over the levee, which keeps back the waters of the river.

The *tympanum*, under the name of the *scoop-wheel*, is much used in the drainage of the fens in the East of England. The name is somewhat confusedly applied to wheels of the tympanum character, and to those with radial buckets which traverse in a chute. These wheels, driven by steam-engines, have, to a great extent, superseded the Dutch windmills and pumps which have been used there for several centuries. In one place, a steam-engine has superseded 44 windmills. In another place, two steam-engines, of 110 horse-power, drain 28,000 acres, and have superseded 75 windmills.

These very efficient wheels have a diameter a little more than double that of the elevation to which the water is required to be raised. Some wheels deliver the water at the axis, and others have floats like an ordinary water-wheel, and merely traverse in a curved, inclined trough of masonry, which connects the lower with the upper level. See SCOOP-WHEEL.

2. (*Architecture.*) The triangular panel of the fastigium or pediment of any building, comprehended between its corona and that of the entablature. The panels of a framed door were called *tympana* by the Romans.

3. (*Music.*) Another name for the tambourine. See Plates LXXVI., LXXVII., Bonanni's "Istromenti Armonici," Roma, 1776.

The tympanum (Gr. *tympanon*) was a hand-drum or tambourine, but covered with parchment, back and front. It was used in company with various kinds of harps, lyres, and pipes, cymbals (*kymbala*) of metal, the straight brass trumpet (*salpinx*) and curved brass horn (*keras*), the castanets (*crotala*) of wood and metal.

The drum is common among all uncultivated nations, and was a prominent feature in the ancient practice. The Egyptian musical instruments were harps, guitars, single and double pipes, two kinds of trumpets, three of tambourines, three of drums, gongs, bells, cymbals, and castanets, the sistrum, maces, and bells.

The largest Assyrian band shown at Khorsabad has a leader with a harp, followed by two with a dulcimer and double pipe; these by two men with harps; then four women with harps;

one beating a drum and another with a double pipe. Then comes a chorus of singers, clapping their hands.

The Hebrew drum (*toph*) was a small hand-drum or *tambourine*, called *timbrel* or *tabret* in the English version; *vide* Miriam and Jephtha's daughter. The hand-drum of some parts of the East is still called *doff*, *diff*, or *adufe*.

**Tym'pa-num, Ar-ti-fi'cial.** (*Surgical.*) An elastic membrane designed to replace the natural tympanum where this has been ruptured. Fig. 6847. Toynbee's consists of a thin plate of vulcanized rubber about $\frac{4}{10}$ inch in diameter, in the center of which a fine silver wire about an inch long is fastened. This has a ring on its outer end, by which it can be easily removed. Clarke's is elliptical in shape, and on being worn becomes concave outwardly; the wire is curved downwardly to suit the shape of the auditory canal, but does not touch its sides. The ring is dispensed with.

*Clarke's Artificial Tympanum.*

Hyde's ear-trumpet has an artificial tympanum to transmit the pulsation of the air to the natural organ. See ACOUSTIC INSTRUMENTS; TELEPHONE.

**Tymp-plate.** A plate in front of the hearth of a blast-furnace, sustaining and proteeted by the *tymp-stone*, which is immediately exposed to the heat. The *tymp-plate* is imbedded at its ends in the side of the hearth, and itself sustains the front. See BOSHES.

**Tymp-stone.** The stone which forms the front of the hearth in a blast-furnace, resting upon and against the *tymp-plate*. See BOSHES.

**Type.** A parallelopipedon or square prism with a raised letter on the upper end, used in printing.

The history of type is a part of the history of printing. Printing from engraved blocks and then from movable letters was practieed in China long before either art was developed in Europe. The same order of invention occurred again in Europe, the "Biblia Pauperum" and other books with engraved pages preceding the movable blocks, which were set up to form words, lines, and pages.

The movable type of China, A. D. 1041, is described in Ringwalt's "Encyclopædia of Printing," page 104, and in this work *supra*, page 1790.

The movable type of Europe is referred to, *supra*, pages 1790, 1791. First made by Guttenberg or Koster (Laurentius Zanssen); first cast by Schoeffer.

The first book executed with cast-metal Fig. 6848. type is said to have been the "Durandi Rationale Divinorum Officiorum," published in 1459. See PRINTING.

For the making of type, see TYPE-FOUNDING.

*Type.*

Fig. 6848 shows a type. The parts have the following names: —

| | |
|---|---|
| *a*, body. | *d*, nick. |
| *b*, face. | *e*, groove. |
| *c*, shoulder. | |

Nicholson (English), 1790, gave type a taper toward the lower end, so as to make them fit upon the circumference of a cyliudrical type-holder.

Donkin and Bacon (English), 1813, effected the object by placing the forms on the plane sides of a revolving prism.

Cowper (English), 1815, curved the stereotype-plates.

Type is improved by facing with copper or with nickel. The nickel has the advantage of allowing the use of some colors, some of which are changed hy the copper, while some others act upon the copper.

Type are distiuguished hy names indicating *size* of the *body* and the consequent number which will go in a given space; hy the different sizes or styles of *face* on a given body; by the *case*, as *upper* or *lower*, caps or small letter; by peculiar style or ornamental characteristic.

As to *size*, —

| | |
|---|---|
| Brilliant. | Agate or ruby. |
| Diamond. | Nonpareil. |
| Pearl. | Minion. |
| Brevier. | Pica. |
| Bourgeoise. | English. |
| Long primer. | Great primer. |
| Small pica. | etc., etc. |

As to *face*, —

| | |
|---|---|
| Full. | Medium. |
| Heavy or fat. | Light. |
| Displayed. | Condensed. |

As to *case*, —

| | |
|---|---|
| *Caps*, or upper case. | Small letters, or *lower case*. |

As to *style*, —

| | |
|---|---|
| Roman. | Antique. |
| Italic. | Black letter. |
| Script. | San Ceriph. |
| Old English. | Old style. |
| Germau text. | Hair line. |
| Gothic. | etc., etc. |

See also FONT, pages 900, 901.

See specimens on pages 2672-2674, kindly furnished by George Bruce's Son & Co., New York.

## SIZES; ROMAN AND ITALIC.

### ROMAN.

DIAMOND, 201.58 lines to a foot. ABCDEFGHIJKLM abcdefghijklmnopqrstuvwxyz.

PEARL, 179.59 lines to a foot. ABCDEFGHIJKL abcdefghijklmnopqr.

AGATE, 160 lines to a foot. ABCDEGHIJKL abcdefghijklmn.

NONPAREIL, 142.54 lines to a foot. ABCDE abcdefg.

MINION, 126.99 lines to a foot. ABCDE abedefg.

BREVIER, 113.13 lines to a foot. ABCD abcd.

BOURGEOIS, 100.79 lines to a foot. ABC DEFGHIJKLMN abcdefghijklmnopqrstu.

LONG-PRIMER, 89.79 lines to a foot. ABCDEFGHIJKL abcdefghijklmno.

SMALL-PICA, 80 lines to a foot. ABCDEFGHIJK abcdefghijklm.

PICA, 71.27 lines to a foot. A BCDEFGHIJ abcdefghijklm.

### ITALIC.

*DIAMOND, half Bourgeois. ABCDEFGHIJKLMNO abcdefghijklmnopqrstuvwxyz*

*PEARL, half Long-Primer. ABCDEFGHIJKLMN abcdefghijklmnopqr.*

*AGATE, half Small-Pica. ABCDEFGHIJK abcdefghijklmnop.*

*NONPAREIL, half Pica. ABCDEFGHI abcdefghijklm.*

*MINION, half English. ABCDEFG abcdefghijkl.*

*BREVIER, half Columbian. ABCDEF abcdefg.*

*BOURGEOIS, half Great-Primer. ABCD EFGHIJKLMN abcdefghijklmnopqrstu.*

*LONG-PRIMER, half Paragon. ABC DEFGHIJKLM abcdefghijklmnopqrst.*

*SMALL-PICA. ABCDEFGHIJK LMNOPQRS abcdefghijklmnopqrs.*

*PICA. ABCDEFGHIJKLM abcdefghijklmnopqrstuvwxyz.*

### VARIETIES OF FACES.

Brevier, Roman, Large-faced.
Brevier, Roman, Heavy-faced.
Brevier, Roman, Compressed-faced.
Brevier, Roman, Joined-Seriff.
Brevier, Roman, Medium-faced.
*Brevier Italic, Large-faced.*
*Brevier Italic, Compressed-faced.*
*Brevier Italic, Medium-faced.*

STYLES.

Brevier Roman Condensed.

Brevier Roman Extra Condensed.

Brevier, Roman, Modern Old-style.

**Brevier Title Roman.**

**Brevier Title Roman Condensed.**

**BREV. EXT.**

Brevier Expanded.

**Brevier Title Expanded.**

**Brevier Aldine.**

*Brevier Italic.*

*Brevier Italic, Modern Old-style.*

***Brevier Title Italic.***

***Brevier Title Italic.***

*Brevier Engravers' Italic.*

*Brevier Law Italic.*

*Brevier Gothic Condensed Italic.*

**Brevier Antique.**

**Brevier Antique.**

**Brevier Antique.**

Brevier Antique.

**Brevier Antique Condensed.**

Brevier Antique Condensed.

Brevier Antique Extra Condensed.

**Nonp. Antique Ext.**

PEARL ANTIQUE EXTENDED.

PEARL ANTIQUE EXTENDED.

**Brevier Clarendon.**

BREVIER GOTHIC.

Brevier Gothic.

**Brevier Gothic.**

**Brevier Gothic.**

BREVIER GOTHIC CONDENSED.

Brevier Gothic Condensed.

**Brevier Gothic Condensed.**

BREVIER GOTHIC CONDENSED.

**BREVIER GOTHIC CONDENSED.**

Brevier Gothic Extended.

Brevier Round Gothic Shaded.

Brevier Celtic.

Brevier Runic.

BREVIER RUNIC.

Brevier Extended Runic.

**Brevier Doric.**

BREVIER ORNAMENTED.

Brevier Ornamented.

**BREVIER SHADED.**

BREVIER SHADED.

BREVIER SHADED.

BREVIER SHADED.

Brev. Ext. Shaded.

Brevier Extended Black.

Long-Primer Arabesque.

LONG-PRIMER ORNAMENTED.

Long-Primer Ornamented.

**Long-Pr. Ornamented.**

**Pica Ext. Rimmed.**

Great Primer Kendrik.

**Brevier Italian Condensed.**

**Brevier Italian Antique.**

LONG-PRIMER Engravers' Hair-line.

*Long-Primer Italic Hair-line.*

Pica Hair-line Shaded.

Pica Condensed Hair-line.

BREVIER GOTHIC CONDENSED HAIR-LINE.

BREVIER OUTLINE.

BREVIER SKELETON.

Long-Primer Engravers' Open.

Pica Old-Style Ornamented.

Brevier German.

**Brevier German Title.**

Brevier Victoria.

**Brevier Black.**

**Brevier Black.**

Brevier Augustan Black.

Long-Primer Black Outline.

**Long-Primer Condensed Black.**

Long-Primer Black Open.

Great-Primer Italian Text.

English Church Text.

**Double S.P. Medieval**

Pica Anglo-Black.

Pica Borussian.

*Pica Script.*

*D. S.P. Running-hand.*

*Great-Pr. Copperplate Script.*

*Double S.P. Italian Script.*

Double English Notarial.

D. P. P. Italian Secretary

Double Pica Graphotype.

Pica Title Script.

D. Pica Penman.

D. Pica Penman.

Double Small-Pica Caligraph.

Double Small-Pica Ronde.

Pica Madisonian.

Pica Secretary.

Pica Venetian.

**Pica Paint Brush.**

See also under the following heads: —

| | |
|---|---|
| Albertype. | Lithotype. |
| Ambrotype. | Logotype. |
| Amphitype. | Melanotype. |
| Authotype. | Melotype. |
| Autotype. | Music-type. |
| Calotype. | Phototype. |
| Chemitype. | Stereotype. |
| Chromatype. | Talbotype. |
| Chrysotype. | Telotype. |
| Crochet-type. | Thermotype. |
| Crystalotype. | Type. |
| Cyanotype. | Type-founding. |
| Daguerreotype. | Type-metal. |
| Electrotype. | Type-setting machine. |
| Embossing-type. | Type-setting telegraph. |
| Heliotype. | Voltatype. |
| Hyalotype. | Wood-type. |

**Type-block.** One having upon it raised figures representing letters or numbers. It is used in impressing or printing words or figures. In the former case, the result is a sunken or intaglio legend, name, or what not; in the latter, the impression is given in printer's ink, or by a hot block upon gold-leaf, to cause it to adhere to the size or *glaire* spread upon the object beneath the leaf. See GILDING. See also TYPE-WHEEL.

**Type-cast'ing.** See TYPE-FOUNDING.

**Type Cast'ing and Set'ting Ma-chine'.** One which makes its type from matrixes, and sets them in a row, or in galley, as the letter-keys of the machine are manipulated in the order of the copy.

Westcott's machine, No. 115,796, June 6, 1871, is constructed to cast, dress, and set up type in a continuous line for solid matter, or book or newspaper work, the line being afterward divided off, justified, and set up into column, as usual. See also his patents 169,215, 169,216, October 26, 1875.

The machine contains keys appropriated to each letter, character, and number that the machine is adapted to cast. When one key is moved it brings into action levers, slides, and other parts, that place a matrix-stock, carrying the matrix corresponding to the letter or mark on the key, in position to be taken by a carrier to the place where the casting is effected The molds forming the body of the type are opened to the proper extent for making the sized body adapted to the letter The type is cast, the matrix is withdrawn, carried back, and replaced in its receptacle. The type is taken out of the mold and brought forward to dressing-tools, that remove from the body of the type any burs, fins, or inequalities, and the type is then set up in line. By this machine the types are cast and composed in the order in which the finger-keys are moved; and when the types are no longer required they are either melted up, instead of being distributed, or else they may be distributed and used in the ordinary way, if desired.

**Type-dis-trib'ut-ing Ma-chine'.** A companion machine to the type-setter. See TYPE-SETTING MACHINE.

**Type-dress'ing Ma-chine'.** One forming a substitute for the usual mode, which is to rub the type by hand upon the plane surface of a stone, using as an auxiliary a scraper or file. Welch's machine passes the type set up in rows between a pair of knife-blades set in exact parallelism.

**Type-found'ing.** The early history of type is that of printing; for though the art of engraving blocks and seals in cameo and intaglio for stamping and sealing had been known for 2,000 years, they only became *type* when adapted for association together for printing and for subsequent distribution.

As stated under PRINTING, the earliest form of printing was from a block engraved with the device or matter; this was common among the Chinese, and in some other quarters. The "Biblia Pauperum," or "Poor Man's Bible," of the 14th century, was thus produced. *Stamping*, or making impressions in ink or color from engraved blocks, is old. The essence of the invention of printing consisted in the idea of movable types, capable of composition and distribution. These were originally cut in wood, and were subsequently cast in metal. The trio, Guttenberg, Faust, and Schoeffer, were so intimately connected in the invention that it is difficult, and perhaps not important, to determine the part each had in the discovery. The world can well afford to canonize them as the benefactors of their race. It should appear that Guttenberg invented cut, movable types, and Schoeffer invented casting them in matrixes, before which time they had been produced by great and tedious labor. The claims of Koster of Haarlem must not be overlooked, but there is no room here to state or balance testimony. (See PRINTING.) For more than 100 years after the invention of printing, the priuters cut their own matrixes, cast their own type, made their presses, composed the type, printed, folded, and bound their own books. In 1686, the branches of the trade were divided as follows: *master-printer*, *letter-cutter*, *letter-caster*, *letter-dresser*, *compositor*, *corrector*, *pressman*, *ink-maker*, *binder*. Caxton seems to have regarded himself as well supplied, having five fonts.

In 1706, William Caslon brought the art of type-making to great perfection, and rendered England independent of the Continental type-founders Caslon was an engraver of gun-locks and gun-barrels, and, having a reputation for ingenuity, was employed by "The Society for Promoting Christian Knowledge" to cut the punches for a font of Arabic. That foundry is still known by his name.

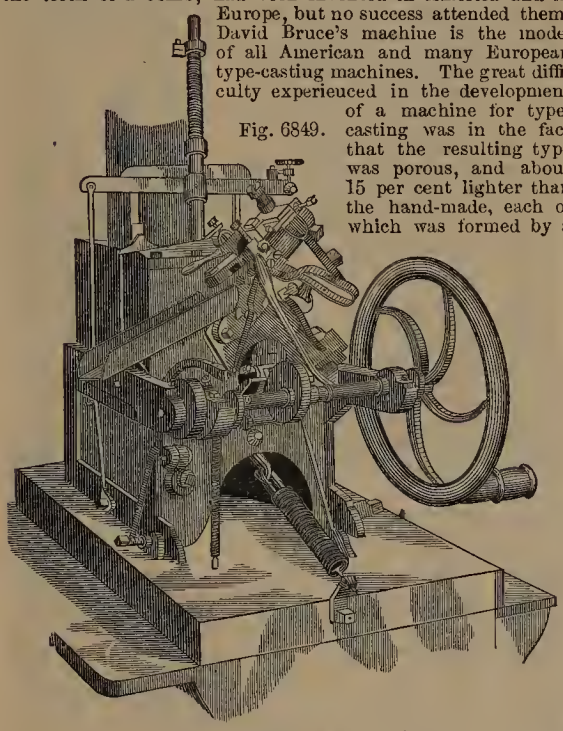
The first type-founder in America was Christopher Saur of Germantown, Pennsylvania, and the first font cast was of German type, about 1735. In 1768, a foundry was established in Boston, but did not succeed. Abel Buell of Killingworth, Connecticut, succeeded, so far as good work was concerned, but was prevented by a turbulent disposition, and by the War of Independence, which supervened, and in which he took an active part, from pursuing the business to a successful issue. Just before the war of the Revolution, he was one of a party who destroyed the leaden statue of George III., in the Bowling Green, New York, and was discovered at his house melting up the head into type-metal, so as to put his Majesty to work disseminating information. A piece of the head, with some punches and matrices, were found many years afterward in the ammunition-chest of an old field-piece to which Buell had been attached during the war.

In 1796, Archibald Binny (as he wrote it then), of Edinburgh, Scotland, came to Philadelphia, bringing with him his own tools; these were seized on his landing in New York, but were afterward released. He established a type-foundry in Philadelphia, and some years afterward took into partnership James Ronaldson The type-founding tools and materials imported by Dr. Benjamin Franklin, from France, for his own use, it is understood were purchased by Mr. Binny and partner. The foundry was successful from the first. It is likely that Mr. Fürstf, a die-sinker at the Philadelphia Mint, may have engraved the punches for A. Binny, as his name occurs as engraver under a likeness of Binny on the obverse of a medal, which has also the inscription, "A. Binny, Letter-founder, Philadelphia"; the inscription on the reverse, under an appropriate group of figures and tools, is, "Letter-foundry of Philadelphia, established A: 1796."

The old hand-mold and spoon reigned supreme till 1838, when the first successful type-casting machine was invented by David Bruce of New York. Machines for casting a number of

types, simultaneously projecting from a common sprue, like the teeth of a comb, had been invented in America and in Europe, but no success attended them. David Bruce's machine is the model of all American and many European type-casting machines. The great difficulty experienced in the development of a machine for type-casting was in the fact that the resulting type was porous, and about 15 per cent lighter than the hand-made, each of which was formed by a

Fig. 6849.



*Bruce's Type-Casting Machine.*

peculiar spasmodic jerk given by the workman to the mold, as he poured in the metal. The effect of this was to condense the metal and expel air. In the Bruce machine, the metal is kept fluid by a gas-jet beneath, and is projected into the mold by a pump, the spout of which is in front of the metal-pot. Each revolution of the crank brings the mold up to the spout, where it receives a charge of metal; it flies back with it, the top of the mold opens, and the type falls out. The matrix containing the letter is held by a spring against the mold opposite to the opening at which the metal is injected, and the rate of making is about 100 per minute, for average-sized type. The saving effected by the machine, patented in 1843, is estimated at 25 per cent. The quality is, if anything, superior, and the machine enables steam power to be used for the production of some varieties of type.

After casting, the *jet*, or surplus metal, at the foot of the type and which filled the ingate of the mold, is broken off; the sides of the type are rubbed on a grit-stone; they are set up regularly in sticks: corrected for inequalities; a groove planed in the middle of the base, forming what are known as *feet*. The proportion of each letter, for a font of a given weight, is arranged in a galley 6 × 4½ inches, and forms what is known as a type-founder's page. This is papered, and marked with the kind of letter contained.

Printing types were first electrofaced with copper in 1850.

A French invention, by M. Didot, was designed to cast about 200 types at once, the operation taking about 20 seconds. The matrixes were arranged in the parts, or jaws, of the machine, and the spaces for the types were connected by grooves, with a reservoir filled with metal. Pressure brought upon the molten metal forced it into all the recesses of the molds.

The apparatus was patented in England by Pouchée, and was long in successful use in London; whether it is yet in use, the writer does not know.

Westcott's machine (United States patents, 115,796, June 6, 1871; and 169,215, 169,216, October 26, 1875) casts and sets the types. The matrices of the letters, figures, and spaces are operated by separate keys, and the cast types are carried to the stick and set up in order. See TYPE-COMPOSING MACHINE.

**Type-mak'ing Ma-chine'.** See TYPE-FOUNDING.

**Type-meas'ur-er.** A stick having upon its sides or edges the measure of the various sizes of type, so as to readily indicate the number of lines by laying it alongside a column of matter or proof, or the *ems* in a line by placing it along the line.

**Type-met'al.** A white alloy for casting type, composed of lead, 3 to 7; antimony, 1.

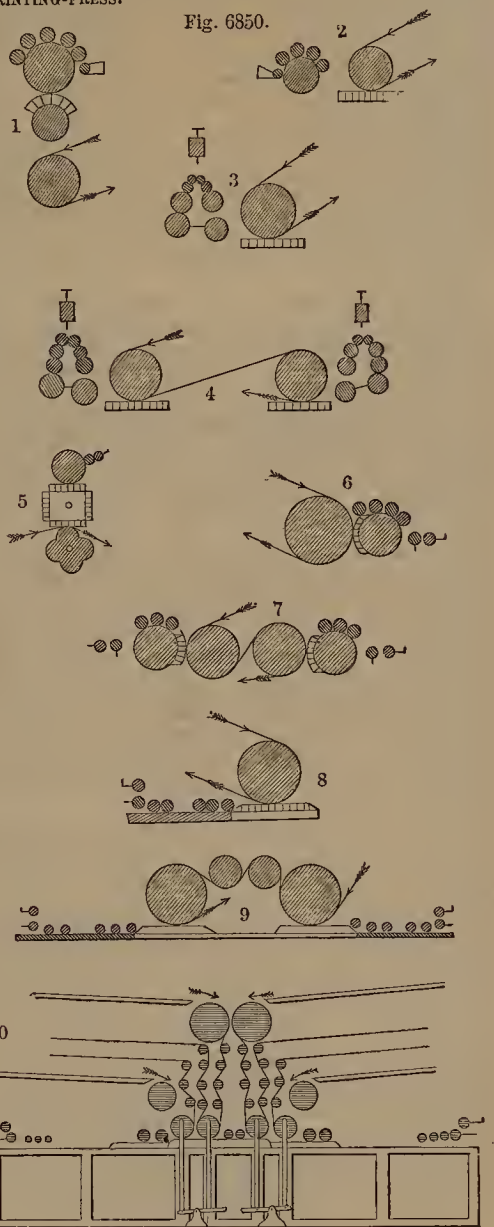
The larger type have the largest proportion of lead. The small type have more antimony, to render them harder and enable them to resist wear.

Besley's patent: lead, 100; antimony, 30; tin, 20; nickel, 8; cobalt, 5; copper, 8; bismuth, 2. See ALLOY.

**Type-re-volv'ing Press.** (*Printing.*) That form of press in which the type is secured on a cylinder, which revolves and presents the form successively to the inking-roller and to the paper. See CYLINDER-PRESS.

Fig. 6850 shows the principles of the type-revolving presses. See PRINTING-PRESS.

Fig. 6850.




*Principles of Type-Revolving Presses.*

1. Nicholson, 1790.
2. Nicholson, 1790.
3. König, 1814.
4. König, 1818.
5. Donkin and Bacon, 1813.
6. Cowper, 1815.
7. Cowper, 1815.
8. Applegath and Cowper.
9. Applegath and Cowper.
10. Applegath, 1827.

Hoe's ten-cylinder machine is described and represented under CYLINDER-PRESS, Plate XI. See also WEB-PRESS; PERFECTING-PRESS.

**Type-set'ting Ma-chine'.** A composing-machine for type. There are several varieties of machines for this purpose. Ordinarily, they have separate pockets or galleys for each *sort*, and the mechanical arrangement is such that on touching the key, arranged with others like the keyboard of a piano, the end type of the row is displaced, and is conducted in

a channel or by a tape to a composing-stick, where the types are arranged in regular order in a line of indefinite length, and from whence they are removed in successive portions to a justifying-stick, in which they are spaced out to the proper length of line required.

Type-distributing machines have frequently been invented as companion machines to those for composing, and are patented with them in some cases. The *distributing*-machine reverses the method of the setter. The *dead matter* is placed on a bed, each line is cut off and the types raised *seriatim*, so that they can be read by the observer. The corresponding key on the keyboard being depressed, the type is pushed into its appropriate tube, ready for supplying the composing-machine. In another machine each sort has its peculiar nick, and the process of selection is automatic.

A machine for this purpose was patented in England, by William Church, in 1822. No. 4,664. It is for an apparatus "for casting the printing types, and also of arranging them in boxes of letters, so that the types of the same denomination are placed side by side, in ranges, ready to be transferred to the composing machinery." In another portion of the apparatus, "the individual types are composed into words and sentences."

Type-setting machines form three groups : —

I. The type, when set free by the keys, fall into inclined grooves, or channels, in which, by their own weight, they descend, one after another, to the receptacle, or composing-stick, provided to receive them. They here form a line of indefinite length, from which they are removed, in successive portions, to a *justifying-stick*, in which they are spaced out to the proper length of lines required. A machine of this kind was exhibited at the Paris Exposition of 1855, by Mr. Sörensen of Denmark; another by Mr. Young of London; and a third by Mr. Delcambre of France. Delcambre's was the only machine of any kind for setting up movable types in the Exposition of 1867.

In all these machines the types are arranged in compact rows, side by side, and in separate but parallel channels, each row occupying a chanuel by itself, and all these channels standing (except in the machine of Sörensen) somewhat inclined, in one plane just behind the key-board. In Sörensen's machine these channels occupy the circumference of a cylinder. Generally, the action of the key displaces the lowest type of the column and delivers it over to the contrivance for transmission to the composing-stick. In Delcambre's, however, the types in each channel are pressed upward from below, and the column has a curvature at the top which brings the upper end to a horizontal position. It is the most advanced type at this extremity of the column which is dropped under the action of the key.

II. This group is illustrated by Mitchell's machine, in which each type, as it is delivered from its receptacle, falls upon an endless band which carries it horizontally for a certain distance directly from the operator, or at right angles to the key-board; when it encounters another endless band at a little lower level, which moves obliquely, or in the direction of the hypothenuse of a right-angled triangle, of which the first band is the base. To this second band it slides gently down a brass shoot, and is carried forward to a point beyond the last of the parallel bands, where it is acted on by a notched wheel called the setting-wheel, which sets it upright and advances it to make room for the next type.

III. Mackee's machine (English patents, 1865, 1866) is operated by means of strips of paper previously perforated so as to represent, by the number and arrangement of holes, the respective letters of a sentence. As the paper passes, by consecutive steps, $1'_{10}$ of an inch across a perforated drum, the pegs of the levers of certain letters enter such perforations as come in correspondence with them and release types which are carried by a traveling-ring to a delivery-channel, where a pusher drives them on to a belt which delivers them in line. See "Ringwalt's Dictionary of Printing," page 291.

See the following patents : —

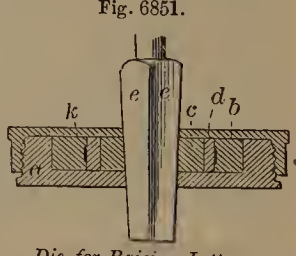
*Type Setting and Distributing Machines.*

| No. | Name. | Date. |
|---|---|---|
| 2,139. | Young and Delcambre | June 22, 1841. |
| 3,257. | Rosenborg | September 9, 1843. |
| 4,313. | Heuning | December 16, 1845. |
| 7,738. | Beniowski | October 29, 1850. |
| 9,413. | Harmon | November 23, 1852. |
| 9,974. | Mitchell | August 30, 1853. |
| 10,656. | Beaumont | March 21, 1854. |
| 10,929. | Mitchell | May 16, 1854. |
| 13,710. | Longborough | October 23, 1855. |
| 339. | Longborough (reissued) | January 8, 1856. |
| 15,310. | Koenig | July 15, 1856. |
| 16,743. | Mitchell | March 3, 1857. |
| 16,947. | Houston | March 31, 1857. |
| 18,175. | Alden | September 15, 1857. |
| 3,572. | Alden (reissued) | July 27, 1869. |
| 18,264. | Mitchell | September 22, 1857. |
| 26,149. | Gilmer | November 15, 1859. |
| 28,463. | Felt | May 29, 1860. |
| 28,857. | Harger | June 26, 1860. |
| 30,211. | Dorsey and Mathers | October 2, 1860. |
| 34,265. | Ray | January 28, 1862. |
| 36,991. | Brown | November 25, 1862. |
| 38,955. | Felt | June 23, 1863. |
| 52,073. | Paulding | January 16, 1866. |
| 52,254. | Allen and Mackay | January 23, 1866. |
| 57,034. | Baer | August 7, 1866. |
| 59,786. | Van Gieson | November 20, 1866. |
| 64,200. | Coney and Harper | April 30, 1867. |
| 71,610. | Harper | December 3, 1867. |
| 75,681. | Houston | March 17, 1868. |
| 84,273. | Foster | November 24, 1868. |
| 85,251. | Slingerland | December 22, 1868. |
| 91,988. | Umstadter | June 29, 1869. |
| 95,853. | Thome | October 12, 1869. |
| 97,801. | Delcambre | December 14, 1869. |
| 100,366. | Brown | March 1, 1870. |
| 102,183. | Thompson | April 19, 1870. |
| 104,236. | Westcott and Rider | June 14, 1870. |
| 105,855. | Slingerland | July 26, 1870. |
| 108,813. | Morgan | November 1, 1870. |
| 108,980. | De la Pena | November 8, 1870. |
| 110,077. | Shipley | December 13, 1870. |
| 113,912. | Neff and Scruggs | April 18, 1871. |
| 114,850. | Plunkett | May 16, 1871. |
| 115,777. | Slingerland | June 6, 1871. |
| 115,796. | Westcott | June 6, 1871. |
| 120,398. | Ray | October 31, 1871. |
| 122,744. | Thompson | January 16, 1872. |
| 126,262. | Brown | April 30, 1872. |
| 126,944. | Farnham | May 21, 1872. |
| 130,485. | Corey | August 13, 1872. |
| 130,982. | Corey | September 3, 1872. |
| 136,018. | Baldwin | February 18, 1873. |
| 137,466. | Moore | April 1, 1873. |
| 138,241. | Gally | April 29, 1873. |
| 138,922. | Oring | May 13, 1873. |
| 140,278. | Kastenbein | June 24, 1873. |
| 140,279. | Kastenbein | June 24, 1873. |
| 142,652. | Ray | September 9, 1873. |
| 149,647. | Foster | April 14, 1874. |
| 150,234. | Farnham | April 28, 1874. |
| 152,869. | Reynolds | July 7, 1874. |
| 152,868. | Reynolds | July 7, 1874. |
| 157,694. | Paige | December 15, 1874. |
| 164,037. | Richards | June 1, 1875. |
| 166,549. | Pattyson | August 10, 1875. |
| 167,726. | Allen | September 14, 1875. |
| 168,044. | Millar | September 21, 1875. |
| 168,591. | Thompson | October 11, 1875. |
| 169,215. | Westcott | October 26, 1875. |
| 169,216. | Westcott | October 26, 1875. |
| 170,372. | Hooker | November 23, 1875. |
| 170,593. | Richards | November 30, 1875. |

**Type-set'ting Tel'e-graph.** One in which the message at the receiving end is set up in type. The title is also held to mean, but does not correctly define, the instrument in which certain letters are made to deliver an impression in consecution, and so spell out the message. See PRINTING-TELEGRAPH.

**Type-wheel.** A disk having raised letters on its periphery, employed for printing or stamping, and in some forms of telegraph, as the Hughes. Various plans have been tried for cleanly and sharply producing the raised letters on the face of the disk.

Fig. 6851.



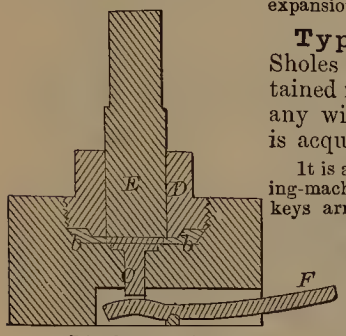

*Die for Raising Letters.*

In Fig. 6851, the annulus *d*, which is to form the tire of the wheel, is placed between segmental plain dies *c* and exterior segmental matrixes *b*, having the letters engraved in intaglio on their inner peripheries; the whole are inclosed in a box *a*, and the inner segmental dies expanded by a tapering plunger *e e*, forcing the metal into the matrixes; or the inner segments *c* may be dispensed with, and the metal expanded directly by the plunger.

In Fig. 6852, the metal is forced into the countersunk letters in the interior of the sectional dies *b b* by a plunger *E* working within the screw-nut *D*, and is afterward lifted by the follower *C*, operated by a lever *F*.

In another plan, the type-wheel is tightly compressed between two circular plates, which completely cover and compress the two lateral surfaces of said wheel, leaving only a

Fig. 6852.




*Die for Forming Letters.*

narrow rim allowed for lateral expansion.

**Type-writ'er.** The Sholes type-writer has attained more popularity than any with which the writer is acquainted.

It is about the size of the sewing-machiue, and is worked with keys arranged iu four *banks* or rows, each type being thrown up as its key is struck.

The types are engraved on the euds of a series of steel bars which are pivoted iu a circle, so that they may vibrate on the pivots, and all strike at the same point in the center of, and a little above, the horizontal plane of that circle. Dircctly over the point where the types all strike, an inking-ribbon, similar to the inking-ribbons used in the common hand-stamps, is drawn, so that every type strikes it in delivering an impression; it is made to move a slight distance every time a key is struck, so that every type will strike it in a fresh place. Directly over the inking-ribbon, the paper carriage moves horizontally from right to left, and the paper is arranged to go under a cylinder or roller, which acts as a plateu, and over the inking-ribbon, so that every time a key is struck a type is thrown up against the inking-ribbon, carrying the ribbon with it against the cylindrical platen, and there it leaves its impression. A weight pulls constantly against the paper-carriage, which is held by a ratchet or trip, which lets go every time a key is struck and catches again, and in the interval the weight pulls the carriage and paper along the space of one letter. By means of a treadle attached to the paper-carriage, a movement of the foot will draw the carriage back to the place of beginning; and as the carriage is drawn back, a ratchet and ratchet-wheel attached to and connected with the cylindrical platen are made to revolve the platen and move the paper the distance desired for a line-space.

This machine has 44 characters in it, as follows: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z & - . , ; : ? ! 1 2 3 4 5 6 7 8 9. The parenthesis and apostrophe ) ' are straight marks. By holding the space-key down while an "1" and "S" are struck, one over the other, a dollar-mark is obtained, thus: $. By striking, in the same way, the period and apostrophe together, an exclamation is obtained, thus: ! ! !

Johnston's apparatus for the bliud is to enable them to write by pressure upon letters in the required order, the finger-letters corresponding to those which print upon the sheet of paper beneath. The disk has a circular series of vertical plungers with raised letters on their lower ends to imprint the paper, which is properly fed beneath. Corresponding with the series of vertical plungers are horizontally moving plungers whose raised letters are exposed on the periphery to the touch of the operator. The letter, being selected, is pressed inward, and the rotation of the disk brings it to the stopping-place, at which an impulse is given to the vertical corresponding plunger. Each selected letter is brought to the same spot, being arrested by engagemcnt with a depression in the stationary ring.

The following patents on type-writers may be consulted: —

| No. | Name. | Date. |
|---|---|---|
| 3,228. | Thurber | August 26, 1843. |
| 4,271. | Thurber | November 18, 1845. |
| 7,652. | Fairbank | September 17, 1850. |
| 7,771. | Eddy | November 12, 1850. |
| 8,980. | Jones | June 1, 1852. |
| 10,995. | Thomas | May 30, 1854. |
| 14,907. | Cooper | May 20, 1856. |
| 14,919. | Jones | May 20, 1856. |
| 15,164. | Beach | June 24, 1856. |
| 18,504. | Francis | October 27, 1857. |
| 22,423. | Harger | December 28, 1858. |
| 38,815. | De Mey | June 9, 1863. |
| 39,296. | Livermore | July 21, 1863. |
| 57,182. | Peeler | August 14, 1866. |
| 59,522. | Flamm | November 6, 1866. |
| 62,206. | Johnston | February 19, 1867. |
| 65,807. | Hall | June 18, 1867. |
| 79,265. | Sholes *et al* | June 23, 1868. |
| 79,868. | Sholes *et al* | July 14, 1868. |
| 81,000. | Pratt | August 11, 1868. |
| 87,941. | Johnson | March 16, 1869. |
| 94,329. | Moore | August 31, 1869. |
| 109,161. | Washburn | November 8, 1870. |
| 115,287. | Draper | May 30, 1871. |
| 118,491. | Sholes | August 29, 1871. |
| 124,437. | Halstead | March 12, 1872. |
| 125,952. | Hanseu | April 23, 1872. |
| 127,739. | Cadmus | June 11, 1872. |
| 133,841. | Edison | December 10, 1872. |
| 139,914. | Pember | June 17, 1873. |
| 140,921. | Hill | July 15, 1873. |
| 144,450. | Galloway | November 11, 1873. |
| 148,946. | Gally | March 24, 1874. |
| 158,071. | Hansen | December 22, 1874. |
| 168,898. | Hansen | October 19, 1875. |
| 169,757. | Alissoff | November 9, 1875. |
| 170,233. | Case | November 23, 1875. |
| 170,239. | Crandall | November 23, 1875. |
| 170,621. | Deming | November 31, 1875. |
| 171,139. | Johnson | December 14, 1875. |
| 171,335. | Allen | December 21, 1875. |
| 171,408. | Morgan | December 21, 1875. |

See also the following English patents: —

| No. | Date. | No. | Date. |
|---|---|---|---|
| 395, of | 1714. | 306, of | 1869. |
| 9,204, of | 1841. | 997, of | 1869. |
| 9,745, of | 1843. | 3,699, of | 1869. |
| 10,939, of | 1845. | 3,234, of | 1870. |
| 868, of | 1854. | 918, of | 1871. |
| 1,110, of | 1854. | 3,177, of | 1871. |
| 674, of | 1856. | 823, of | 1872. |
| 1,050, of | 1856. | 990, of | 1872. |
| 1,969, of | 1857. | 1,912, of | 1872. |
| 101, of | 1863. | 2,161, of | 1872. |
| 2,031, of | 1863. | 2,239, of | 1872. |
| 295, of | 1864. | 2,481, of | 1872. |
| 893, of | 1864. | 3,548, of | 1872. |
| 1,983, of | 1864. | 668, of | 1873. |
| 2,260, of | 1864. | 3,852, of | 1873. |
| 3,257, of | 1864. | 927, of | 1874. |
| 1,412, of | 1864. | 1,786, of | 1874. |
| 2,687, of | 1864. | 2,131, of | 1874. |
| 1,186, of | 1866. | 3,528, of | 1874. |
| 1,448, of | 1866. | 2,119, of | 1875. |
| 3,163, of | 1866. | | |

French patent, 7,028, of 1840.

**Ty-po-graph'ic Ma-chine'.** One in which the depression of keys operates type in the proper succession to impress a matrix, from which a stereotype plate may be cast.

Sweets's machine is described and figured in Dr. Barnard's "Report of the French Exposition of 1867," pages 443 – 448. It resembles a parlor-organ in appearance, having in front one or more banks of keys, the number corresponding to the number of sorts to be employed in the work.

Flamm's typographic compositor is shown and described in the same work, page 449.

See also TYPE-WRITER.

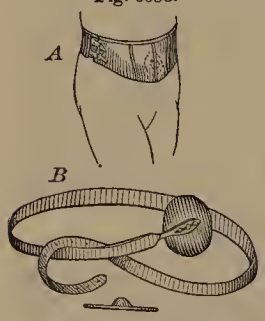
# U.

**U-dom'e-ter.** An instrument to determine the quantity of rain-fall. A *rain-gage* (see pages 1871–1874). An *ombrometer* or *pluviameter*.

**Ul'tra-ma-rine'.** A blue color, originally prepared from lapis lazuli, but now usually produced by chemical means. The credit of first artificially producing this beautiful pigment at a price enabling it to be extensively employed in the arts appears to be due to Guimet.

**Um-bil'i-cal Band'age.** (*Surgical.*) A broad band of fabric which is buckled around the umbilical region of the body to serve as an abdominal supporter and for palliating umbilical hernia.

Fig. 6853.




*Umbilical Bandage and Truss.*

Some have hard pads of wood, cork, or metal, and others are provided with pads of sponge, horsehair, or other sort material, or of india-rubber inflated with air (*A*, Fig. 6853).

*B* is an umbilical truss, designed for the same purposes.

**Um-brel'la.** A light frame covered with fabric and held above the head as a protection against sun or rain. The name in the Latin is from the word *umbra*, "shade," and has been perpetuated in *umbrella*, which means "a little shade," and is similar to the Roman word *umbraculum*. The term *parasol* is now used rather for a sun-shade, the *umbrella* being principally a protection against rain. This distinction is not closely maintained; it is a matter of climate.

Umbrellas were in common use many centuries ago in China, and their paper parasols, called *kittysols*, are largely exported thence.

In Asiatic countries (and, indeed, in Africa, both ancient and modern), the umbrella has, from ancient times, been regarded as a symbol of royalty or nobility. The form exists in the Buddhist *topes* and Hindoo pagodas. It is too much to assume that the umbrella is the type of Chinese architecture, as that is evidently tent-like, and is incident to the swaying of ropes, or of the somewhat pliable materials in a land of bamboo: of that, presently. It is pretty certain, however, that the umbrella, as a sign, bad reference to the *linga* in the phallic worship of the East, which was afterward repeated farther west in the worship of Dionysius, at the Arcadian feasts, where he was exposed under an umbrella, which came to be regarded as his emblem, and appears in several basso-relievos and Etruscan vases. As with the treatment by the Greeks of the Egyptian pantheon and rites, so with the Dionysiac worship imported from India; the ceremonies became orgies, and the festivals of Bacchus became a mere saturnalia, where the devotees dressed as satyrs, the antitype of the modern Carnival. Even the more sedate *Father Liber* of the erudite Pliny did not escape infection.

To establish the parallel more distinctly, it may be said that, in the fifth incarnation of Vishnu, the god goes down to tophet with an umbrella in his hand. Dionysius is also represented descending, *ad infernos*, with a small umbrella. In one feast of Athene, a white parasol was borne by the priestesses of the goddess from the Acropolis to the Phalerus.

Mr. Ferguson states, in his "Handbook of Architecture," that the umbrella is shown in the cave of Karli, in India, and supposes the sculpture to be over eighteen hundred years old. The umbrella so used is called a *tee*. The *tee*, or tope finial, is a prominent feature in some Oriental buildings, especially the Chinese. The pagodas are a series of umbrella-like roofs. One, two, and a terminal, like other illustrations of the law of climax, may have had something to do with the triple crown or tiara. The machinery of worship in Europe, and here, so far as imported, is mostly of Asiatic origin, — bells, rosaries, censers, robes, and banners, the common property of the Aryan nations, from the Ganges to the Atlantic. See PRAYING-MACHINE.

The "Tcheou-Li," a book of Chinese ceremonies, about A. D. 300, specifically directs the shape, size, and construction of the umbrella to be raised over the royal car. It had 28 ribs, and an extension-handle. We read of 24 umbrellas being carried before the Emperor of China, when going hunting; and that, in the second Tartar invasion of China, the Emperor's son was made to carry an umbrella over the head of his captor.

Fig. 6854.

*Persian Umbrella (from Persepolis).*

The accompanying cut (Fig. 6854), from a sculpture at Persepolis, represents attendants carrying a parasol and fly-flap over a Persian chief. The framework of the parasol was probably light, but it does not seem that it was collapsible. The Chinese probably had folding-umbrellas at that time. An umbrella, apparently made of feathers, is represented in a Theban tomb. It is carried over the head of an Ethiopian princess, who is riding in an Egyptian plaustrum, such as Pharaoh or Joseph sent for Jacob, and called "wagon" in the "authorized" translation of the Bible.

Fig. 6856 is a parasol from the Royal Palace, Nimroud. Rawlinson says that the parasol was exclusively used by the monarch.

Pliny speaks of *umbracula* made of split leaves of the palm, and used for covering the head. From the context, it should appear that he referred rather to a palm-leaf hat than an umbrella.

Fig. 6855.

*Egyptian Umbrella (from Thebes).*

The *flabellum*, or fan, or, as we may call it, the feather-brush or duster, was commonly carried by the attendants of people of rank, and was used as a shade, fan, or fly-brush. See FAN.

The umbrella was the θόλιον of the Greeks, the *umbraculum* of the Latins. It was a parasol or sunshade, carried by the Roman ladies or by attendants, known as *umbelliferæ*. It was made to open and close, like the modern umbrella, but was somewhat more clumsy. The Greek ladies used it in the theater, as did also the Roman. Its use was considered effeminate in a man. They were commonly of green linen stretched upon a frame and supported by a staff. Such are represented on ancient vases, and frequently referred to by contemporary writers: Aristophanes, Ovid, Anacreon, Martial, Juvenal, etc. The Hamilton vases show several instances of Greek and Etruscan umbrellas. Xerxes and Cleopatra are represented as sitting under canopies or umbrellas, watching the fight or the play. The Greek ladies wore straw hats and bonnets (Pollux, "Theocr."). The Roman men wore broad-brimmed felt hats, *petasus* (*wide-awakes*).

Fig. 6856.

*Parasol at Nimroud.*

Christie describes an Etruscan vase in which Bacchus presents a dove to a seated female, while an umbrella is held above their heads by another female.

Fig. 6857 is from the Harleian Manuscript, No. 603, and represents a servant holding an umbrella over his master. Its use during the Middle Ages in Europe is frequently noted in monkish chronicles.

Fig. 6857.

*Anglo-Saxon Umbrella.*

They are mentioned in Florio's "Worlde of Wordes," 1598 ("*ombrella*, a fan, a canopie; also a testern or cloth of state for a prince; also a kind of round fan or shadowing that they vse to ride with in summer in Italy; a little shade"), and by Ben Jouson, in a comedy, 1616, and were used by ladies in the time of Queen Anne. Du Cange mentions the custom of contracting and expanding them. Cotgrave, in his "History of the English and French Tongues," speaks of the French *ombrelle*. Montaigne refers to its use in Italy.

M. de la Loubère, ambassador

from France to Siam, 1687–88, states that the King of Siam had a triple umbrella, several frames and covers being fastened to the same stick. This was a royal right. The nobles had single umbrellas. Common people stood in the sun. The Siamese monks (*Talapoins*) had palm-leaves cut and folded, so that the stem formed a handle.

Tavernier describes the umbrellas on each side of the throne of the Great Mogul, and those at the court of the king of Ava, whose title was, and perhaps is, "King of the White Elephant and Lord of the Twenty-four Umbrellas." The Mahratta prince, at Poonah and Sattara, was known as "Lord of the Umbrella." The same regard is paid to its use in Burmah, Assam, Yemen, Constantinople, Morocco.

As appears by the "Female Tattler" of December 12, 1709, the umbrella was only designed as a protection between the door and the carriage. Jonas Hanway, who died in 1786, has the credit of contemning public opinion, and defying the coachmen and sedan-chair men, who deemed it their monopoly to protect from rain.

It was made, in those days, of oiled silk, upon a heavy frame. The substitution of silk and gingham, and a light, elastic frame, have contributed to its popularity.

The account in the "Female Tattler" states to the "young gentleman belonging to the custom-house who, for fear of rain, borrowed the umbrella at Will's coffee-house, Cornhill, of the mistress," that "to be dry from head to foot, on the like occasion, he shall be welcome to the maid's pattens." Gay mentions the umbrella as early as 1712, in his poem of "Travia," in which he says: —

"The tucked-up seamstress walks with hasty strides,
While streams run down her oiled umbrella's sides."

Mr. J. Jamieson, a Scottish surgeon, brought with him from Paris, in 1781, an umbrella, which was the first seen in Glasgow, where he resided, and where it attracted universal attention.

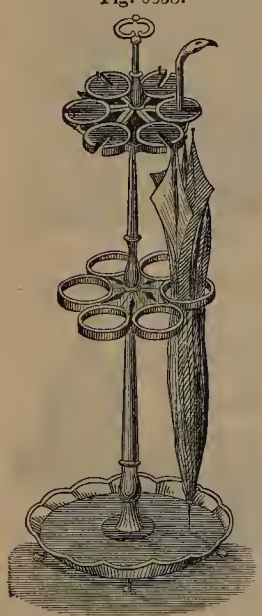
About 1774, "umbrilloes" were mentioned as being used in Boston. They were large, blue, with a ferrule like a small pagoda, and wood enough in the handle for a harpoon-stock.

In the manufacture of umbrellas and parasols, the system of the division of labor is carried to a high degree of perfection, enabling the commoner qualities to be produced exceedingly cheap.

In preparing an ordinary umbrella-stick, it passes through 19 separate processes or movements; each of the ribs requires 13 distinct manipulations, making 104 for the 8 ribs. "Weighing" the ribs, to give them all an equal flexure, requires 8 more transfers from hand to hand, and threading the ribs to the stretchers brings up the total series of operations required for the frame to nearly 150. Within comparatively few years, this cost, in London, from ½ *d.* to 2½ *d.* each, for common umbrellas and parasols; one man and four boys can put together 100 frames daily. For covering each frame, women received from 1 *d.* upward.

A tradesman in Bristol, England, has just made a monster umbrella for an African chief. It is 65 feet in circumference, the lancewood ribs being 6 feet long, and there are 140 yards of material in it. It is covered with red, blue, and white chintz, and takes two men to expand it.

Fig. 6858.



*Foote's Lock-Stand for Umbrellas.*

In Trinidad are colonies of ants, "known as parasol ants, from the fact that each individual carries a leaf in his mouth, which shades his back. These luxurious insects, on being disturbed, rush into their holes and bring out a lot of very large chaps with big heads and tremendous nippers, who at once assume an attitude of self-defence, being, in fact, the bullies of the establishment, while the gentle parasol-bearer stands aside to watch the fun. This is almost as surprising as Sir John Lubbock's statement that some tribes of ants keep milch cows, and also an old beetle, whom they worship as an idol." — TALBOY'S *West India Pickle.*

A traveler near Manjee, a small town at the confluence of the Gogra and the Ganges, mentions a banian-tree which resembled an immense umbrella, being of a pyramidal shape, sloping from a central summit to the extremity of the lower branches. The limbs of these trees extend out a distance horizontally, and then let down to the ground a number of leafless fibers, which presently take root, coalesce, and increase in bulk, so as to support the protracted branches like supplementary trunks. From these new centers of vegetation other arms again spring out, and at their terminations form a third series of stems, so that a full-grown banian-tree composes a whole grove in itself.

The central part, in the instance cited, is over 100 feet high; the diameter of the ground covered is 363 feet from north to south, and 375 feet from east to west. The circumference of the shadow at noon is 1,116 feet. The number of props about 60.

**Um-brel'la-stand.** The umbrella-stick, above the ends of the bows, is slipped into the notch of one of the disks, and the latter being partially rotated, becomes locked, so that the umbrella cannot be withdrawn without using a key-check. Fig. 6858.

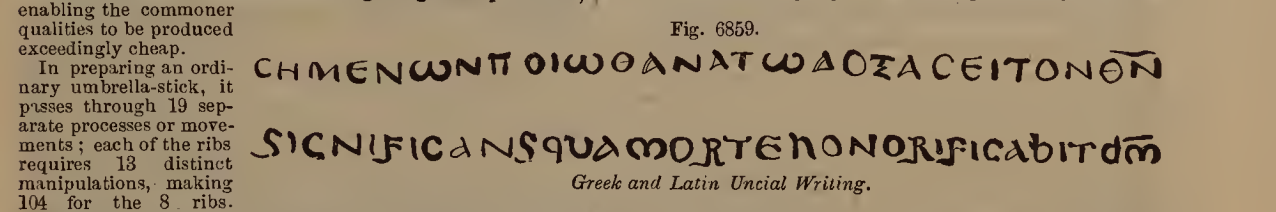
**Um'laut.** A double dot over the vowels *a*, *o*, *u*, in German, indicating a certain quality in the sound of the letter, as in Müller, which is pronounced as "Mueller," nearly.

**Un'cial Writ'ing.** So called from the letters being an inch (Lat. *uncia*) long. The uncial letters are distinguished from the more ancient by their rounded forms, indicating a cursive style. The ancient letters were all capitals; these were so modified, by the introduction of a cursive style, that a new alphabet grew out of it; what we term smaller letters, or lower case. The uncial shows the modification in form, before the distinction of *capitals* and *lower case* was made.

The passage from John xxi. 19, "Signifying by what death he should glorify God," is from a MS. of the sixth century, the four Gospels and Acts of the Apostles in Greek and Latin.

This form of writing began to take the place of capitals in the

Fig. 6859.



*Greek and Latin Uncial Writing.*

middle of the fifth century A. D., and prevailed till the eighth, and in some cases to the tenth century. Its progress was parallel with, or rather a part of the same evolution which, by cursive habits and greater neatness of execution, introduced the *minuscule* or *small-hand* which was adopted in the tenth century, using capitals only for the special positions, occasions, and subjects.

**Un'der-back.** The vessel beneath the mash-tun which receives the *wort* from the latter. From the underback the *wort* is pumped into the copper, where it is boiled with the hops. The operation is called *mashing*. See MASH-TUN.

The name *underback* is also applied to a similar vessel in a vinegar factory.

**Un'der-cut.** (*Founding.*) Those parts of a pattern which hold the sand so as necessarily to tear and break it when the *draw* is made perpendicularly, are said to be under-cut. By using a three-part box, dividing the pattern at a suitable place, or using a *false core* or *draw-back*, difficulties of this kind can always be overcome.

**Un'der-ground-railway.** One wholly or in large part beneath the street surface of a city.

The city of London is now intersected by a perfect network of subterranean railways, extending from the central business portions of the town to the suburbs. The running hours are from 5.10 A. M. to 12.40 P. M., and, during the busy portions of the day, trains leave and arrive at the principal stations every three minutes. The cars are drawn by locomotive-engines, and are divided, as is usual on English railways, into first, second, and third class; the average fare on the latter, which convey more than two thirds of the whole number of passengers, being twopence.

The first portion of the Metropolitan Underground Railway, from Bishop's Road to Farringdon Street, was opened January 10, 1863. In that year the number of passengers was 9,455,000; in 1864, 11,722,000; in 1865, 15,763,000; in 1866, 21,273,000; in 1867, 23,405,000; in 1868, 27,708,000; and, in 1869, up to June 30, the number of passengers was 20,000,000; receipts, £190,000.

The Fourth Avenue of New York is largely occupied, beneath the street level, by the common track of the Hudson River, Harlem, and New Haven railways.

**Un'der-lay.** 1. (*Mining.*) When a vein hides or inclines from a perpendicular line, it is said to underlay.

2. (*Printing.*) Paper laid back of the tympan sheet in order to create local pressure on certain parts of the sheet of paper in the act of printing, and thereby increase the strength of the impression at such points.

**Un'der-lay'er.** (*Mining.*) A perpendicular shaft, sunk to cut the lode at any required depth.

**Un'der-lay-shaft.** (*Mining.*) A shaft sunk on the course of the lode.

**Un'der-lev'el Drift.** (*Mining.*) A drift driven from the pumping-pit to draw off the water from dip-workings.

**Un'der-lie.** (*Mining.*) The *dip, inclination,* or *slope* of a *stratum,* or a vein of ore. *Underlay.*

**Un'der-met'al.** The position of a gun when the muzzle is depressed below the line of a level axis.

**Un'der-pin'ning.** 1. Supports, temporary or permanent, introduced beneath a wall already constructed. *Undersetting.*

As a consequence of raising the grade of Chicago streets, many buildings had to be raised and *underset.*

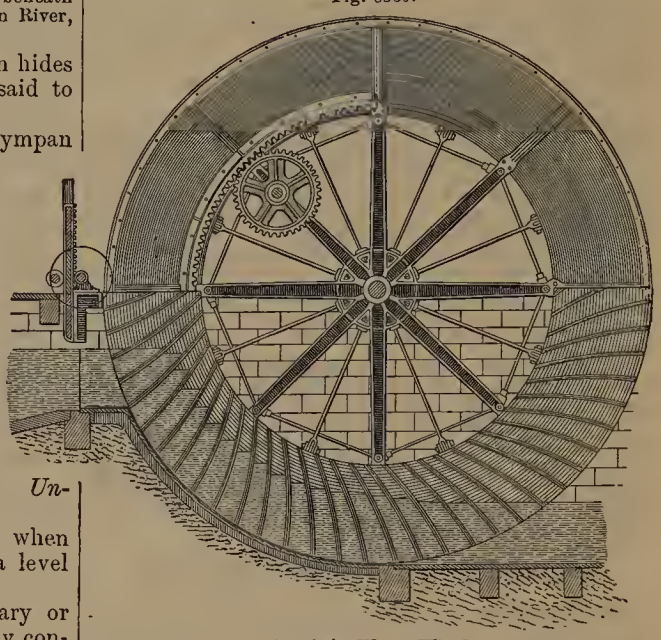
2. A system of sinking brick-lined shafts.

A hole being dug, having a diameter the size of the required cylindrical brick structure, an annular curb of heavy oak is laid at the bottom; the width of the curb is equal to the thickness of the wall which is built thereon. A hole is then dug in the center of the floor, and inclined props are placed beneath the curb. These constitute the underpinning. The earth is then excavated beneath the curb to a depth allowing masons to work. A second curb is laid on the new floor, and the brickwork is laid thereon and carried up to the curb above. Thus the work proceeds, a section at a time; the upper structure in each case being underpinned while a section is being inserted below.

**Un'der-set'ting.** The operation of supporting earth in a cutting when situated beneath rock. A retaining-wall is built against the face of the earth-bank. See also UNDERPINNING; a synonymous word.

**Un'der-shot Wa'ter-wheel.** A water-wheel moved by water passing beneath: in contradistinction to the *overshot,* in which it is received above; the *breast*-wheel, in which it is received at or nearly on a level with its axis; the *turbine,* in which it runs through; and some others. See list under WATER-WHEEL.

Fig. 6860.



*Sagebein Water-Wheel.*

The Sagebein wheel (Fig 6860) is adapted to a very slow flow of water, from 2½ to 3 feet per second, the circumferential velocity of the wheel being from 2 to 2½ feet per second. The buckets are placed tangentially to a circle described, with a radius equal to from $^1/_8$ to $^1/_5$ the radius of the wheel, and the pitch being usually small. The depth of the buckets is usually made equal to the hight of the fall when the latter does not exceed 4½ feet, and the width of the wheel is from $^1/_2$ to $^2/_3$ of its radius. The diameter of the wheel is usually made equal to 10 feet $\times$ $^3/_4$ of the fall. In that illustrated, the buckets have a slightly curvilinear shape, and the above-stated proportions have been somewhat departed from, it being intended for running at a higher velocity.

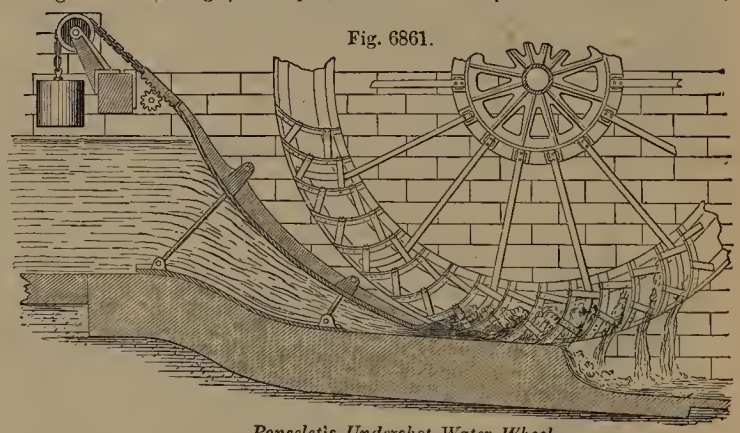
Poncelet's water-wheel (Fig 6861) has buckets of a curvilinear form, open at the back, without a sole-plate, to secure ventilation. The water impinges upon each bucket at nearly the lowest point of the wheel, the shuttle being arranged to draw upward; and as the water enters it follows the curve of the bucket, rises and falls over into the next in succession. In this way the force of the water is expended directly upon the wheel, instead of a portion being wasted in its passage along the sluice.

The illustration is of one erected in Catalonia, having a diameter of 16 feet 8 inches, and width of 30 feet. The buckets are of ⅛ inch wrought-iron, the arms of wrought-iron, and the main shaft is made up of short cast-iron cylinders 4′ 6″ in diameter, bolted together.

The fall of water was 6′ 6″, 120,000 cubic feet per minute passing when the periphery of the wheel moved 11 to 12 feet per second. The sluice-gate was formed of cast-iron plates with planed joints flanged and bolted so as to form one large shuttle the whole breadth of the wheel. It was connected by radial tie-rods with the stone apron of the sluice, and could be raised with great facility by racks and pinions, and regulated by the ordinary governor, the weight of the gate being in a great degree supported by the counterbalance weights.

The sluice-gate moves between the side walls of the pen-trough, and cup-leathers at each side prevent the waste of water.

Fig. 6861.

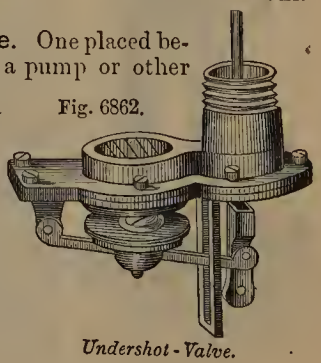


*Poncelet's Undershot Water-Wheel.*

**Un'der-shot-wheel.** See UNDERSHOT WATER-WHEEL.

**Un'der-shut-valve.** One placed beneath the sole-plate of a pump or other object, and not upon it; shutting underneath by an upward motion.

Fig. 6862.



*Undershot-Valve.*

**Un'der-the-Top.** (*Mining.*) A term used where it is necessary to leave part of the coal, in the roof of a gallery cut into the form of an arch.

**Un-dock'ing.** The

process of launching a ship, built in a dry-dock, by allowing access of water to the dock.

**Un-hair'ing.** (*Leather Manufacture.*) The process of removing hair from hides. This is performed by the action of lime, which dissolves the hair sheath and combines with the fat of the hide to form an insoluble soap. The lime is suspended in water in pits, and the hides placed therein, being occasionally *handled*, that is, *taken out*, *drained*, and *replaced* in the pit, examination determining when the process is complete.

The hides are then removed, laid over a beam, and the hair and epidermis removed by the *unhairing-knife*.

Substitutes for lime have been anxiously sought, and the following have been used; objections occur to some of them from the occurrence of a softening and incipient putrefaction of the hide.

Hanging in a smoke-house heated by a smoldering fire.

Piling in a heap and covering with spent tan.

Steaming.

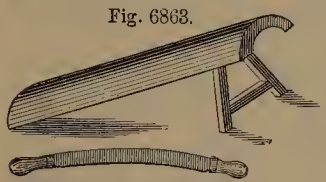
Piling in manure.

Suspension in a confined atmosphere saturated with spray. See Muspratt, II. 575.

Baths of dilute acids, sour milk, fermented bran or meal. See Muspratt, II. 514.

Warrington used sulphide of calcium, which loosened the hair and softened the epidermis in from 24 to 34 hours.

Fig. 6863.



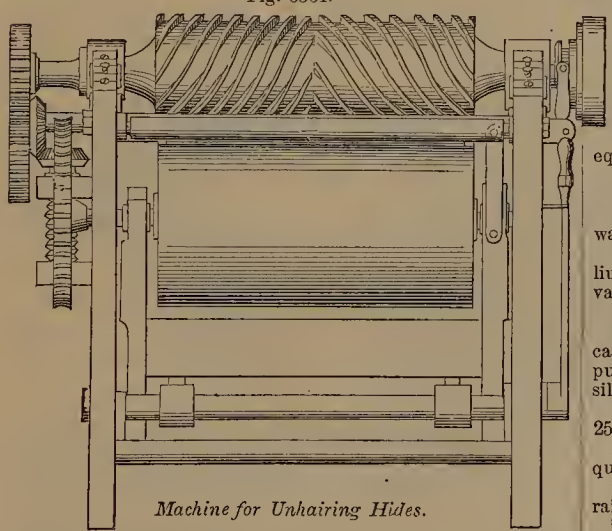
*Unhairing Beam and Knife.*

**Un-hair'ing-knife.** A curved, two-handled iron scraper, for removing the hair from hides which are taken out of the lime-pit and laid over the *beam* for that purpose. The beam is semi-cylindrical, and the knife is concave, to fit the curvature.

**Un-hair'ing-ma-chine'.** One for removing hair, and sometimes flesh, from hides.

Fig. 6864 is a machine for removing hair from hides. It consists of a cylinder having cast upon it helical screw-blades, running from the middle of the cylinder to each end. Below this cylinder, which revolves upon a shaft, is another cylinder larger in diameter than the upper one, the shaft having its bearings in a frame. The two cylinders are caused to revolve

Fig. 6864.



*Machine for Unhairing Hides.*

by means of suitable gearing, the former revolving much faster than the latter; the latter may also be raised or lowered by means of cams on the shaft.

**Un'ion.** 1. (*Hydraulics.*) A tubular coupling for pipes. See PIPE-COUPLING.

Fig. 6865 shows several forms.

*a* is a common union, with a ball to prevent the sinking of the water above it.

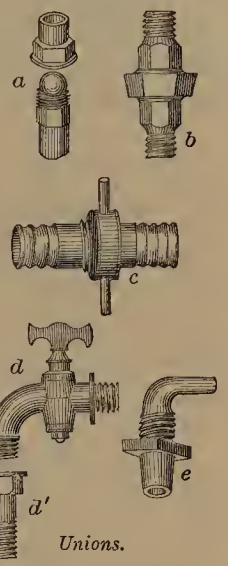
*b*, a gun-metal steam union.

*c*, a *hose*-union. See HOSE-COUPLING.

*d*, a union for bib-cocks, the joint on the end for the *hose*-union *d'*, and the shank end screwed for iron pipe.

*e*, *ceiling*-union.

Fig. 6865.




*Unions.*

2. (*Fabric.*) A fabric of flax and cotton.

3. The upper corner of a flag, against the staff, the other portion being the *fly*. See Fig. 2005, page 875, and description.

The name of *union* is derived from the combined crosses of St. George and St. Andrew (the patron saints of England and Scotland respectively), which were united to form the flag of Great Britain when the two countries were united under King James I., who was previously James VI. of Scotland; and a wretched business he, his son, and his two grandsons made of it. The name *jack*, which distinguishes the *union* without the *fly*, was from the said Jacques, who in uniting the countries became the Union Jacques, which the jolly tars made *union jack*.

**Un'ion-joint.** A pipe-coupling. See UNION; HOSE-COUPLING; PIPE-COUPLING; JOINT.

**Un'ion-pump.** (*Hydraulics.*) One in which the engine and pump are united in the same frame.

**Un'ions.** (*Fabric.*) Mixed goods. Cotton, flax, jute, silk, and wool are united in various binary or trinary combinations.

**U'nit.** A single one of a thing or of a number, forming the basis of count.

The *unit of numeration* is one (1), taken in the *abstract*. *Concrete units* express also character, as one foot, one dollar, etc.

The terms *decimal* and *duodecimal* units express that the numbers increase by scales of ten or twelve respectively.

A *fractional unit* is a single one of the parts expressed in the terms of the denominator, as $\frac{1}{4}$ is the unit of the fraction $\frac{3}{4}$.

A *unit of measure* is a conventional quantity, as a foot, a bushel. Some of these conventional units are specific proportional parts of objects of known magnitude, or determinable by something more than a mere arbitrary measure of comparison.

Such are: —

The English yard $= {}^{1}/_{1.08710}$ parts of the length of a second's pendulum vibrating in vacuo in the latitude of London at the level of the sea, in a temperature of 60° Fah.

The United States standard foot is ${}^{12}/_{39.1012}$ of the length of a seconds' pendulum in the City Hall of New York.

A French *meter* is ${}^{1}/_{10000000}$ of the distance between the equator and the pole, measured on a meridian. A meter is equal to 39.37 inches English. See METRIC SYSTEM.

An hour is ${}^{1}/_{24}$ part of a mean solar day.

Other units of measure are: —

The *specific-gravity unit*: for solids, 1 cubic foot of distilled water at 60° = 1; for air and gases, 1 cubic foot of air at 60° = 1.

The unit of minute or microscopic measurement, as for the lines in spectrum analysis, is the wave-length of light, the mean value of which is about ${}^{1}/_{50000}$ of an inch.

A *unit of value* is a conventional quantity.

In England; a pound sterling, represented by a gold coin called a sovereign, weighing 123.374 grains, and having ${}^{11}/_{12}$ of pure gold. The pound sterling, A. D. 672, was a pound troy of silver.

In the United States; a gold coin, called a dollar, weighing 25.8 grains, one tenth of which is alloy.

A *dynamic unit* is one which forms a basis for expressing the quantity of a force, as

The *unit of mechanical power*: foot-pounds; that is, 1 foot raised 1 foot high per minute.

The *unit of horse-power*: 33,000 pounds raised 1 foot high per minute.

The *unit of atomic weights*: hydrogen, 1.

The *unit of heat*, or *thermal unit*, employed in Great Britain, is the quantity of heat which corresponds to 1 degree of Fahrenheit's scale in the temperature of 1 pound of pure liquid water, at about 39° Fah.

The *thermal unit* of France is the quantity of heat which corresponds to an interval of 1° Centigrade in the temperature of 1 kilogramme of pure water at about 3.94° Centigrade.

Rumford, in 1798, endeavored to ascertain the number expressing the precise relation between the functions of force and heat, known as the *mechanical equivalent of heat*. He used a

solid plunger rotating against the bottom of an iron cylinder submerged in a box of water. Mayer and Joule farthered the experiment, the latter using paddle-wheels rotated in oil, mercury, or water, by the force of a descending weight. The conclusions were, that the descent of 772 pounds 1 foot would raise the temperature of 1 pound of water 1° Fah.; therefore, 772 pounds = 1 unit of heat, and conversely, 1 unit of heat would produce a force of 772 foot pounds; consequently, 42.7 units of heat must be equal to 33,000 foot pounds = 1 horse-power.

The London unit of illumination for photometric estimate of gas (and it is understood that the Metropolitan Gas Company of New York is similar) is the light of a sperm candle burning 120 grains per hour.

The standard for gas is that the flame, burning at the rate of five cubic feet per hour, shall give a light equal to the light of 14 sperm candles, each consuming at the rate of 120 grains per hour.

The *units of electricity.*

The *unit of resistance* of the British Association (B. A. unit) is called an *ohm*, from the German savant Ohm, who reduced the measurement of electric forces to a system.

Siemen's *unit of resistance* = .9554 of an *ohm.*

Varley's *unit* = about 25 *ohms.*

The *unit of tension*, or electro-motive force, is called a *volt*, from the illustrious name Volta. It does not differ greatly from a Daniel's cell, which is = 1.079 *volt.*

The *unit of quantity* is called a *farad*, from the philosopher Faraday; it is that quantity of electricity which, with an electro-motive force of one *volt*, will flow through a resistance of one *megohm* (1,000,000 *ohms*) in one second.

The *unit of current* is a current of one *farad* per second.

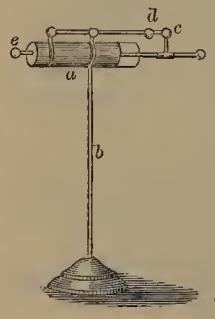
The *unit of work* is that which will produce a velocity of one meter (39.37 inches) per second, in a mass weighing one gramme (15.44 grains) after acting upon it one second of time.

The *electro-chemical unit* is a quantity of current that will decompose .143 grain of water, or generate 1.02 cubic inches of gas per second, the amount of zinc consumed in each cell being .513 grain.

**U'nit-jar.** (*Electricity.*) An instrument devised by Sir W. Snow Harris for measuring definite quantities of electricity.

It consists of a small Leyden jar *a* insulated by being mounted upon a glass rod *b*. Attached to the brass wire which connects the inner coating of the jar with an electrical machine is a sliding brass-ball *c*. The electricity repelled from the exterior coating is conveyed to the surface to be charged from the ball *e*. When the jar is charged to a certain amount, determined by the distance apart of the balls *d c*, a spark passes between these balls and discharges the jar, which is again recharged by the machine; by counting the number of sparks and noting the distance between the balls, the number of equal but arbitrary units which have been repelled from the outer coating on to a larger surface, as a large Leyden jar or battery, may be ascertained.

Fig. 6866.




*Unit-Jar.*

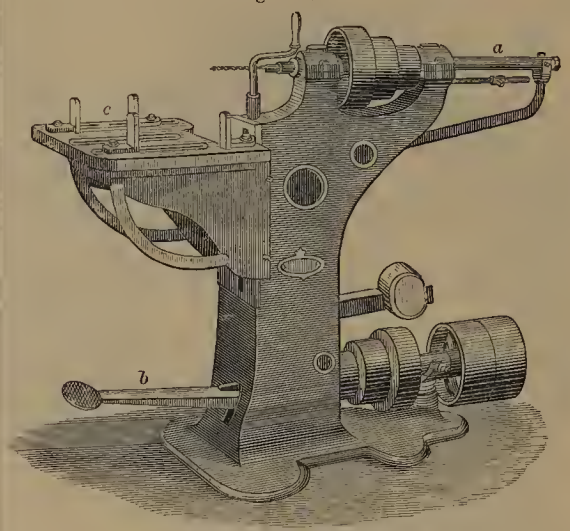
**U-ni-vers'al Bor'ing-machine'.** (*Wood-working.*) A machine adapted to a great variety of work with tools of varying sizes, and the work presented in numerous positions.

In the machine (Fig. 6837) the mandrel *a* which carries the auger is traversed by a foot-lever *b*. The table *c* has adjustable rests enabling the wood to be presented to the tool at any desired horizontal angle, and may be inclined and held at any angle not exceeding 45° with the bit. It may also be raised or lowered to suit the character of the work. Three cone-pulleys are attached for graduating the speed of the mandrel to suit different-sized bits.

**U-ni-vers'al Chuck.** A chuck having movable dogs on a face-plate, so operated as to move radially simultaneously, to adapt them to grasp objects of varying sizes.

**U-ni-vers'al Com'pass.** (*Drafting.*) A compass having tubular legs containing extension-pieces, which may be drawn out to strike a large circle, and fixed at the required length by set-screws. The extension-pieces are also tubular, each receiving either leg of a small bow-compass, one having a plain point and pen and the other a plain point and pencil-holder; these are used as parts of the large compass,

Fig. 6867.

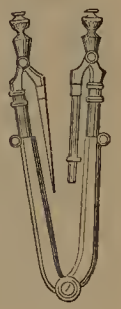



*Universal Boring-Machine.*

but both may be withdrawn and used independently for drawing small circles.

**U-ni-vers'al Coup'ling.** One in which the parts united are capable of assuming various angular relations to each other. A *gimbal-joint* is a familiar instance, — an invention of that versatile gentleman, Dr. Hooke. See UNIVERSAL JOINT; FLEXIBLE COUPLING.

Fig. 6868.



*Universal Compass.*

**U-ni-vers'al In'stru-ment.** A reflecting instrument invented by Professor Piazzi Smyth. It is a sort of reflecting circle, in which a spirit-level with a very small bubble is so placed that by means of a lens and a totally reflecting prism an image of the bubble is formed at the focus of the telescope, and the coincidence of the center of that image with the cross-wires shows when the line of collimation is truly horizontal.

**U-ni-vers'al Joint.** A device for connecting two objects, as the ends of two shafts, so as to allow them to have perfect freedom of motion in every direction within certain defined limits.

The gimbal-joint was invented by Dr. Hooke.

In one form (*a*, Fig. 6869) it is the common mode of uniting the tumbling-rods which connect the horse-power and the thrashing-machine, clover-huller, wood-saw, or other agricultural implement.

The ends of two coupling-rods are pivoted to the arms of a cross having a freedom of motion in planes at right angles to each other. This allows flexure in any direction.

In another form (*b*) the heads on the ends of the coupling-rods are pivoted by pins in a ring; the pins are at right angles, and the effect the same as that just described.

*c* is a ball-and-socket joint in which the ball of one section is held in the socket of the other by means of an annular cap secured by its flanges to those of the socket.

A somewhat neater job (*d*) may be made by making a screw cap instead of a flanged cap.

Mariners' compasses, barometers, chronometers, and some other seafaring instruments are mounted in gimbals (*e*), so as to maintain an even position, horizontal or perpendicular, as the case may be, whatever may be the changes in the position of the vessel.

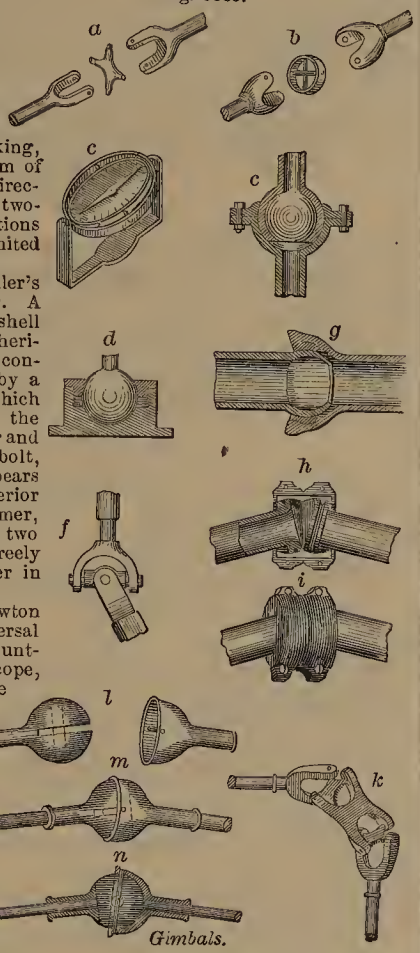
*f* is Dr. Hooke's gimbal. A ring is suspended by studs on diametrically opposite sides, so as to have a freedom of motion in one vertical plane, and within this ring the object itself is suspended on an axis through the diameter and at right angles to the former.

The double gimbal (*k*) has been contrived for positions where a flexure of over 140° is required.

It is used to obviate the vibratory and unsteady motion incident to the action of the ordinary form of this joint. Between the two shafts to be connected, a short intermediate shaft is introduced, making equal angles with the two principal shafts, connected with each by a Hooke joint, and having both its own forks in the same plane.

*g* is a flexible joint for water-mains. The sphero-segmental end of one pipe passes into the enlarged end of the other, and is surrounded by an annular water-tight packing.

Fig. 6869.




Gimbals.

*h i*, a flexible pipe-joint. The flanged ends of the pipes have annular grooves to receive packing, and have freedom of motion in all directions within a two-part box, the sections of which are united by bolts.

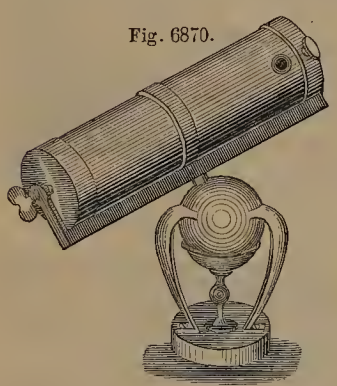
*l m n*, Keller's shaft-coupling. A globular slotted shell enters a hemispherical shell, and is connected thereto by a pin or bolt which passes through the sides of the latter and through an axial bolt, which merely bears against the interior wall of the former, permitting the two shells to move freely about each other in all directions.

Sir Isaac Newton contrived a universal joint for the mounting of his telescope, which was made about 1675, and is now in the possession of the Royal Society, to whom it was presented by the illustrious philosopher.

See COUPLING; BALL-AND-SOCKET JOINT; GIMBAL.

**U-ni-vers'al Syr'inge.** (*Surgical.*) A syringe to be used for various purposes, having irrigating-nozzles of various shapes and sizes, for reaching different portions of the body, washing out wounds and ulcers, injecting caustic solutions, etc. The various attachments are applicable to the uterus, male and female urethra, and bladder; ear, larynx, nares; a hard rubber stop-cock fits the catheter, or trocar, for hydrocele, etc.

Fig. 6870.



*Newton's Universal Joint.*

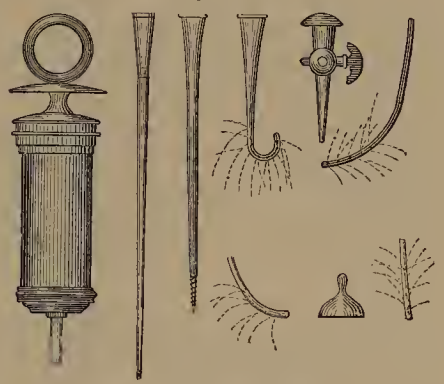
**Un-load'ing Ma-chine'.** An apparatus for removing freight from boats, cars, or wagons.

The usual form for unloading freight in bulk is that of a series of cups on an endless band. See ELEVATOR.

For unloading freight in bags, sacks, boxes, barrels, and other packages, the device generally consists of a traveling platform or endless chain.

One is at St. Louis, belonging to the Grain-Elevator Company. At intervals of 4 feet on the moving platform are fixed blocks, to hold barrels and hogsheads in place, the width being 4 feet, sufficient for a hogshead of sugar. It is run by steam,

Fig. 6871.



*Tiemann's Universal Syringe.*

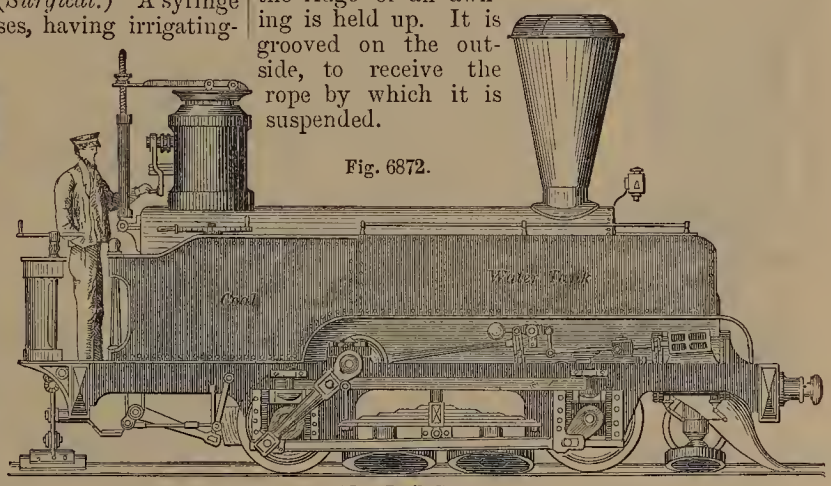
and is capable of unloading 1,000 barrels of sugar, 700 barrels of salt, or 150 hogsheads of sugar per hour. Sacks of grain can be unloaded as fast as they can be put on and taken off. It extends a distance of 50 feet, and reaches from the guard of the boat from which goods are to be unloaded a considerable distance into the warehouse. It is also arranged so that it can be adjusted to high or low water.

**U'no-rail.** A traction system for ordinary wagons, in which a single rail is laid for the locomotive, which has nearly horizontal wheels to grasp the rail. The wagons are coupled on the rear. See Fig. 6872; also CENTER-RAIL.

**Up'cast-pit.** (*Mining.*) The pit up which the air ascends after ventilating the mine; in contradistinction to the *downcast*.

**Uph'roe.** (*Nautical.*) A long piece of wood with several holes, through which pass the cords by which the ridge of an awning is held up. It is grooved on the outside, to receive the rope by which it is suspended.

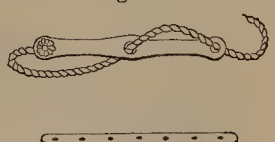
Fig. 6872.



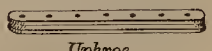

*Uno-Rail System.*

The *uphroe* and its cords form a *crow's-foot*. Sometimes spelt EUPHROE (which see).

Fig. 6873.



An analogous device is also adapted in some forms of *bag-holder*, and shown in the upper figure.



*Uphroe.*

**Up'per.** The part of a boot or shoe above the sole and welt and forward of the ankle-seams.

**Up'per-leath'er.** The vamps and quarters of boots and shoes.

**Up'per-ma-chines'.** (*Boot-making.*) A term which includes all those for cutting out or preparing the uppers of boots or shoes. Among these are *crimping*, *trimming*, *seam-rolling*, and *turning* machines.

**Up'right.** 1. (*Carpentry.*) A pillar or post in a frame or other structure.

2. (*Steam.*) A term synonymous with *vertical*, as applied to a boiler whose hight is greater than its width; and to a steam-engine in which the stroke is perpendicular. See list under STEAM.

3. (*Wood-working.*) A term applied to a molding-machine whose mandrel is perpendicular. See Fig. 4916, page 2133.

**Up-set'ting.** Contracting a heated metallic object by endwise blows. In thickening the end of a rod to form a head it is *spread* by blows directed endwise.

Shortening tire, to enable it to bind the fellies more firmly, is called *upsetting*, and is presumed to be done by cutting the tire, and then shortening by the process described, after which the tire is re-welded. It is, however, oftener done by cutting out a piece and re-welding. The name is retained, but no *upsetting* occurs. See TIRE-SHRINKER; TIRE-UPSETTER.

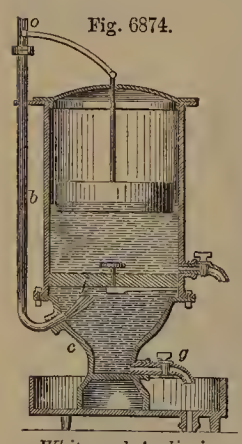
**Up-set'ting-press.** See FORGING; STEEL-PRESS; TIRE-UPSETTER; etc.

**Up'take.** (*Steam.*) The upcast pipe from the smoke-box of a *steam-boiler* furnace, leading to the chimney or stack.

**Up'ward Fil'ter.** A filter in which the flow of the liquid is upward, giving a certain degree of facility for cleansing the material, by directing a current of clean water in the reverse direction, and giving a downward discharge.

In White and Aveline's artificial spring or upward filter (English), the water is taken from a cistern and admitted by a pipe *b* into the lower chamber *c* of the filter. It then passes through the porous stone *f* into the upper chamber, whence it is drawn as required. A float on the surface of the water acts upon a faucet *o* to allow the flow of water as the supply of filtered water fails.

Fig. 6874.




*White and Aveline's Upward Filter.*

When the water in lower chamber *c* becomes muddy, the faucet *g* is opened and the contents discharged, thus flushing the chamber and washing off the bottom of the stone. See also FILTER.

In Turkey, a method of filtering water by ascension has been practiced, the arrangements for which are contrived as follows: —

Two wells are dug at a small distance apart, and partially filled with sand and gravel. The opening of that into which the water to be filtered is to run must be somewhat higher than that of the one into which it ascends; this latter should not be quite filled with the filtering material, so that there may be room for the filtered water, or the water may be conducted by a spout into a reservoir. Two casks, tubs, or other vessels may be used. By this method the particles of sand or other filtering material used do not rise and mingle with the filtered water in the receiving-vessel.

**U-ran'i-co-plas'tic In'stru-ments.** (*Surgical.*) For ingrafting in cases of deficiency of the soft palate. The instruments are similar to those used in *staphyloraphy*, operation for cleft palate. See STAPHYLORAPHIC INSTRUMENTS.

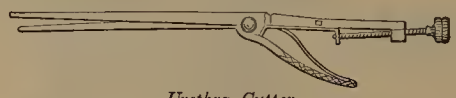
**U-ra'ni-um.** Equivalent, 60; symbol, U.; specific gravity, 18.4; fusible under the blow-pipe. Used in coloring porcelains and enamels.

**Ur'chin.** One of a pair of rapidly revolving small card cylinders, arranged around the periphery of a large card drum.

The *urchins* of a pair are of unequal size, and are called the *worker* and *cleaner* respectively. The former takes the tussocks from the large card drum, disentangles them, and parts with them to the *cleaner*, which returns them again to the large drum. They then pass to the next pair of *urchins*, and so on, being thus laid straight, ready for spinning. See CARDING-MACHINE.

The name *urchin* is derived from a certain resemblance it bears to the little animal the urchin, or hedge-hog, which is covered with spines.

Fig. 6875.

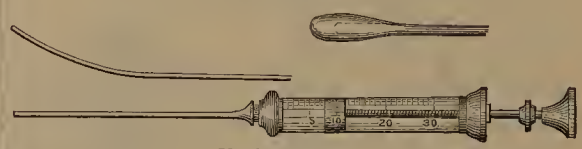


*Urethra-Cutter.*

**U-re'thra-cut'ter.** (*Surgical.*) An instrument for enlarging the urethral canal by cutting, in case of stricture.

**U-re'thra-syr'inge.** (*Surgical.*) A syringe with a long nozzle, for introducing medical preparations or irrigating any prescribed portion of the mucous membrane lining the male urethra.

Fig. 6876.



*Urethra-Syringe.*

The glass barrel is graduated so as to determine the quantity injected.

**U-re'thra-tome.** (*Surgical.*) *a.* A knife for dividing strictures of the urethra.

*b.* The instrument of Le Cat, with which he divided the skin and laid open the urethra in lithotomy.

**U'ri-nal.** A vessel to receive urine.

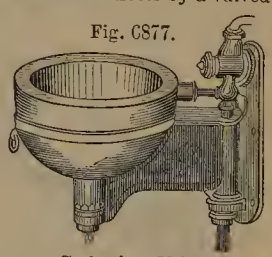
A public basin for convenience of passers by, or in *cabinet d'aisance*.

A reservoir, with conductor, adapted to the penis in cases of incontinence of urine. Its shape and character depend upon its adaptation for the person walking, sitting, lying.

The *gastra* or vase placed in the streets of ancient Rome.

One form is adapted to the mattress, for a bedridden patient. A bowl in the depression of the mattress connects by a valved tube with the chamber-pot. The tube passes through the lid of the vessel, and the valve yields to the fecal discharge.

Fig. 6877.



*Swinging Urinal.*

The swinging urinal (Fig. 6877) turns on a vertical hinge, and on being swung into position for use, opens a valve admitting a jet of water for cleansing it.

Burton's urinal has a cascade dome of water, which continually falls into the basin and runs into the outlet, acting as a trap to prevent the upward passage of noxious gases from the drain.

The most elaborate system of urinals in any public building on record was that in the Coliseum of Vespasian. The building was of an oval form, the major and minor diameters being 620 and 513 feet. Hight, 157 feet, in 4 stories, of different orders of architecture. The area of the site is 249,804 feet. The elliptical arena is 287 by 180½ feet; not quite an acre.

It was calculated to seat 23,362 persons, and each story had its urinals for the respective sexes. The drains were of stone, carefully jointed and luted, and led down through the pillars and the masonry of the staircases, carrying off also the rain-water, which fell in the uncovered building of nearly 6 acres. Few buildings have been so well calculated for large gatherings of persons who remain for several successive hours. All the contents of the drains were eventually conducted to the Cloaca Maxima. This was the chief sewer of Rome, and was built by Tarquinius Priscus (558 B. C.) and his successors. It was 14 feet in width, and 32 feet high, having a sectional area of 448 feet. See CRESY, edition of 1865, pages 110–116.

**U-ri-nom'e-ter.** (*Surgical.*) A hydrometer adapted for indicating the density, natural or otherwise, of human urine.

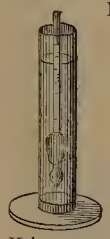
Diodorus Siculus relates that the second Sesostris was cured of blindness by washing his face in the urine of a chaste female. He tried that of a great many, till he met with an effective sample. He burnt on suspicion all the persons who proved ill

adapted to his need, including his own wife. He erected two obelisks at Heliopolis to celebrate the cure. The monolith in the Place Concorde, Paris, is understood to be one of the pair.

**Urn.** A vessel enlarged in the middle and provided with a foot or pedestal; used for holding liquids, for ornamental purposes, and, anciently, for preserving the ashes of the dead after cremation.

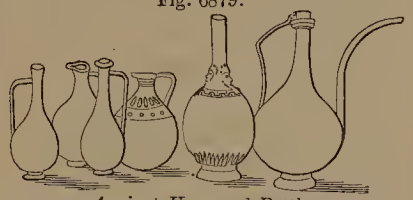
The difference between the *urn* and the *vase* is not very obvious. The latter term, however, would seem to be more generic, embracing that class of vessels generally which are oval or bounded in vertical section by lines of double curvature.

Fig. 6878.



*Urinometer.*

Fig. 6879.

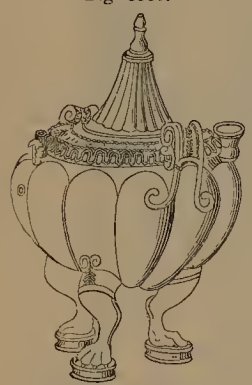


*Ancient Urns and Bottles.*

In Fig. 6879, the three to the left are Egyptian; the next, Etruscan; the succeeding one, Chinese; and the last from Egypt.

Urns are now used as a part of table service, for drinks utterly unknown to the European nations, — *coffee*, *tea*, and *chocolate*.

Fig. 6880.



*Roman Urn (Museo Borbonico).*

Fig. 6880 is a Roman urn from the Museo Borbonico.

See also Rawlinson's "Five Great Empires," Vol. I. page 386.

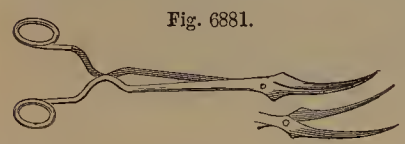
Urns were used anciently for the ballot, for wine, perfumes, and for cinerary remains. Those for ballots were the wide-mouthed *cistæ*, for holding tickets for the people; narrow-mouthed *cistellæ*, for receiving the votes.

**Use.** (*Forging.*) A slab of iron welded to the side of a bar near the end, to be drawn down by the hammer in prolongation of the length of the bar. One mode of building up heavy shafts for paddle-wheels, etc.

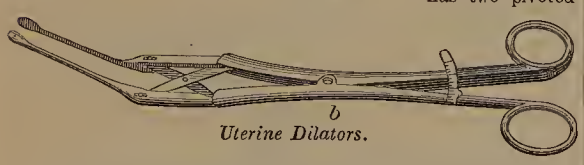
**U'sine.** A glass-house.

**U'ter-ine Di-lat'or.** An instrument for dilating the *cervix uteri*, when contracted. The instrument is made like a forceps, with blades about two inches in length, and answers in the place of graduated metallic bougies in distending the internal *os*.

Fig. 6881.



Ellinger's (*b*) has two pivoted



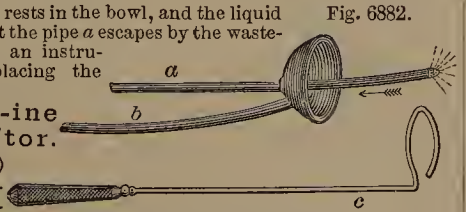
*Uterine Dilators.*

braces connecting and strengthening the blades, and a graduated arc attached to one hand for indicating the amount of dilation.

**U'ter-ine Douche.** (*Surgical.*) A form of irrigator for the uterus.

The cervix rests in the bowl, and the liquid introduced at the pipe *a* escapes by the waste-pipe *b*. *c* is an instrument for placing the douche.

Fig. 6882.

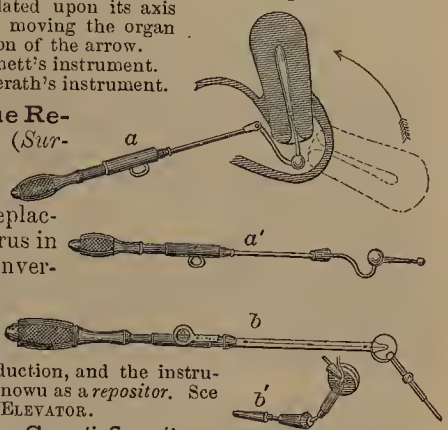



*Byrne's Uterine Douche.*

**U'ter-ine El'e-va'tor.** (*Surgical.*) An instrument for replacing the prolapsed uterus, restoring it to its natural position. The instrument includes various members; one enters the *cervix* and extends to the *fundus*. The entering portion is then oscillated upon its axis on the stock, moving the organ in the direction of the arrow.

*a a'* is Emmett's instrument.
*b b'*, Noeggerath's instrument.

Fig. 6883.




*Tiemann's Uterine Elevators.*

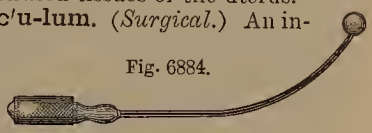
**U'ter-ine Red-dress'or.** (*Surgical.*) An instrument used in replacing the uterus in cases of inversion.

The operation of restoration is known as reduction, and the instrument also is known as a *repositor*. See also Uterine Elevator.

**U'ter-ine Scar'i-fi-ca'tor.** (*Surgical.*) A lancet concealed in a cannula, and used in scarifying engorged or effused tissues of the uterus.

**U'ter-ine Spec'u-lum.** (*Surgical.*) An instrument for distending the canal of the uterus to expose the interior surface of the latter, as in cases of polypus or cognate disorders. See Speculum.

Fig. 6884.

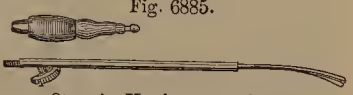


*Uterine Redressor.*

**U'ter-ine Sup-port'er.** (*Surgical.*) An application within the vagina to sustain the womb in cases of *relaxation* or *prolapsus*.

It consists of a cup to receive the *cervix uteri*, and a supporting bow. It is made of hard rubber, and weighs but little more than half an ounce.

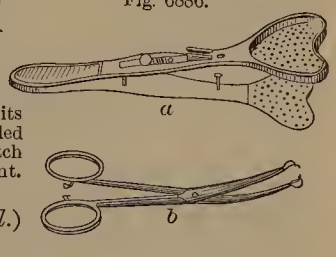
Fig. 6885.



*Storer's Uterine Scarificator.*

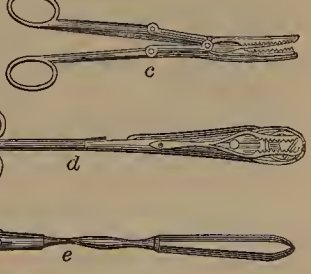
From the cup, in which the *cervix uteri* rests, the bow sweeps down the posterior wall of the vagina, and the lower portion rests upon, and is supported by, the *levator ani* muscle near its attachment to the *os pubis*. The entire posterior or convex portion of the bow resists the action of the downward tendency of the uterus in the cup, while the bladder pushes the anterior wall of the vagina into the concavity of the bow, which in turn is so constructed that it clasps the parts, and is thereby aided in keeping its position. Room is provided for the urethra in the notch at the base of the instrument. See also Pessary.

Fig. 6886.




**Uv'row.** (*Nautical.*) See Uphroe.

**U'vu-la-for'ceps.** Celsius, first century A. D., describes the use of the uvula-forceps; and an instrument supposed to be for that purpose was found by Dr. Savenko in 1819 in a house in Pompeii. It is pictured in Smith's "Dictionary of Antiquities," page 274, and is in the Museum at Portici, together with lancets, spatulas, a cautery, catheters, needles, a tenaculum, probes, etc., found at the same time and place. See Surgical Instruments.




*Uvula-Instruments.*

**U-vu'la-tome.** A cutting instrument for operating on the uvula.

*a*, tongue-holding forceps.
*b*, vulsellum.
*c*, uvula-scissors with claws.
*d*, Tiemann's uvulatome.
*e*, Green's double hook.

# V.

**Vac'ci-na'tor.** (*Surgical.*) An instrument for introducing vaccine virus beneath the skin.

The puncturing-tube, with virus in its aperture, is pressed through the skin, and the virus driven into the wound by the force of the spring when the trigger is pushed in.

"The king of Prussia has commanded his army to be inoculated [vaccine matter], and it is believed that Nassau and Bavaria will compel a universal inoculation in their dominions. Exterminating the small-pox and annihilating the little princes and states of Germany, are the two great projects of the reforming part of Germany." — *Monthly Magazine*, London, May 1, 1801.

*Inoculation*, which, prior to the great discovery of Jenner, was regarded as the best protection against the horrors of the small-pox, was practiced in China at a very early period, and probably found its way to Europe by the same secret channels as those arts whose footsteps are so difficult to trace. Western Europe obtained it from the Turks in 1721, Lady Mary Wortley Montagu having made the first experiment of its efficacy by inoculating her son while residing at Constantinople, in 1718.

*Vaccination* was discovered by Jenner in 1796. *Inoculation* is the older and more generic term; the name *vaccination*, derived from the source of the pustule matter coming later, as we see in the current news of that day.

**Vac'u-um-ap'pa-ra'tus.** A mode of or device for producing a proximately complete or partial vacuum.

See AIR-PUMP for the most familiar form, and list under AIR-APPLIANCES for a number of less common devices.

See CONDENSER for the applications of a jet or cold surface to the production of a proximate vacuum in steam-cylinders.

See ASPIRATOR, DEPURATOR, and TROCAR, for various medical uses.

See AIR AS A WATER-ELEVATOR; EJECTOR; INJECTOR; STEAM-JET; Sprengel pump (Fig. 393, page 170), for applications of a blast of steam or air for the production of a partial vacuum for various purposes.

See VACUUM-PAN for one of the earliest uses of the idea in evaporating solutions.

**Vac'u-um-brake.** (*Railway.*) A form of steam-operated car-brake, in which the general construction of the brake is analogous to that of the Westinghouse. The power employed is the pressure of the atmosphere produced by creating a vacuum instead of that due to compressed air. It is the invention of J. Y. Smith of Pittsburgh.

**Vac'u-um-cyl'in-der Cock.** (*Steam-engine.*) A valve in a steam-cylinder to allow air to enter behind the piston when a partial vacuum has occurred in the cylinder.

**Vac'u-um-fil'ter.** One in which the operation is expedited by exhausting the air beneath the filtering-machine.

**Vac'u-um-gage.** (*Steam-engine.*) An instrument for indicating difference between the external atmospheric pressure and the pressure inside a partially exhausted vessel; such as

A steam-boiler which has become cold and in which the steam has condensed.

A condenser in which the steam from the cylinder is condensed.

The receiver of an air-pump. See BAROMETER-GAGE.

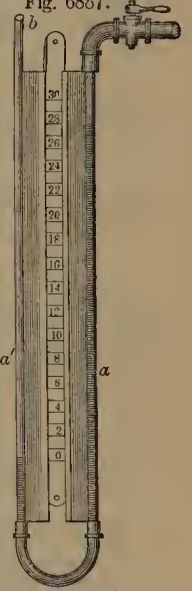
Fig. 6887 shows a gage attached to the condenser to indicate the perfection of the vacuum in the latter.

It consists of an inverted siphon-tube half filled with mercury, one end *b* having a minute opening communicating with the air, and the other connecting with a cock leading to the condenser. When this is opened, the engine being in operation, the mercury rises in the leg *a* and descends in *a'*. The zero at the lower part of the sliding-scale is brought in apposition with the upper surface of the mercurial column in *a'*; the difference in inches between this and that in the other leg is shown by the scale, and shows the difference between the atmospheric pressure and that inside the condenser.

**Vac'u-um-pan.** A vessel for boiling saccharine juices in vacuo in the process of making sugar. It was the invention of Howard, an Englishman (Nov. 20, 1813), and is the leading feature in the improved sugar-apparatus.

It was formerly made of copper, but has been lately made of iron. Its form is usually nearly spheroidal, but it has been made cylindrical. In the spheroidal form, it is made in two segmental or nearly semi-globular portions, which are united at the equator by exterior flanges having holes for bolts. At the top is a dome, into which the vapor rises, and from which it is drawn either by a pump or a condenser. In the Degrand train, the vapor is condensed by an ingenious device which is the chief feature of novelty in his apparatus. (See CONDENSER, DEGRAND.) At the bottom of the pan is the discharge-pipe, guarded by a valve or stop-cock. Another pipe introduces the juice or sirup, and this has also its stop-cock, and may proceed from a reservoir or from the chamber of the pump which injects the liquid to be treated. In some cases, an optional discharge-pipe leads to another pan, and in working "the double effect," the vapor from the boiling liquid in one pan is made to boil the sirup in the next pan. The heating is done by steam under pressure introduced into a steam-jacket around the lower hemisphere of the pan, and by a coil which occupies a position around the inner surface of the said lower hemisphere. Stop-cocks enable the regulation of the flow of steam, and means are afforded for withdrawing the water of condensation. In addition to the described means for introducing and withdrawing the juice, or sirup, heating the liquid, and withdrawing the vapor, windows on opposite sides enable the boiling to be observed, the engineer looking through one while the other admits light. An unpracticed eye has some difficulty in distinguishing anything, but the engineer can readily detect the condition and progress of the boiling mass. A proof-stick affords means for withdrawing a small portion for testing; a gage-glass shows the hight of the liquid in the pan; a steam-gage, the pressure in the steam-jacket and coil; a thermometer, the temperature; and another gage, the pressure in the pan.

Fig. 6887.




*Vacuum-Gage.*

The peculiar feature of the *vacuum-pan*, from whence is derived its value and its name, consists in its being adapted to boil while a portion of the atmospheric pressure is removed. This is accomplished by making it air-tight, and withdrawing the air and vapor from the upper hemisphere by means of air-pump or condenser, as has been stated. By the exclusion of the air, the quality and quantity of the crystallizable sugar are increased, a smaller proportion of grape-sugar or molasses being obtained. A part of the atmospheric pressure being removed also enables the juice or sirup to be boiled at a lower temperature.

The vacuum-pan was long used in the sugar-refineries of England and the United States before it was introduced into the sugar-houses of the plantations. It is now generally known in Cuba, Brazil, and Louisiana, where the business is conducted extensively and methodically. The old Jamaica train of open kettles, however, holds its own where the means of the proprietor or the extent of the plantation forbid the outlay for the vacuum-train.

For plantation use, several vacuums are used in combination, as is more particularly described under SUGAR-MACHINERY, it being the practice to boil the juice to a given gravity after the first defecation and filtering, and after a second treatment in defecators and filters to boil it down to the point of granulation. The usual form of the Derosne vacuum-train is what is called the *double effect*; that is, two pans stand side by side, one of which is boiled by the steam rising from the sirup in the other, the sirup being also drawn at intervals from the first to the second. A *treble effect*, by extending the principle to a third pan, has also been tried, without valuable results from the amplification of the idea.

In the Yngenio San Martin sugar-works, a train of three pans is used, the middle one being the largest, and discharging its steam into the others. The Degrand condenser is used in connection with the pans. See Fig. 1421, page 609.

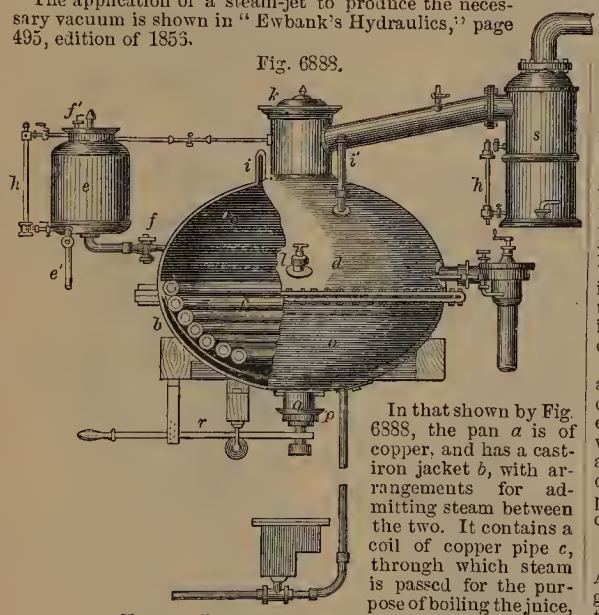
In using the vacuum-pan, the sirup is run in as quickly as possible, until the whole of the heating surface is covered; the steam is then turned on, and the temperature maintained at 180° to 190°. When the sirup begins to granulate, the temperature is lowered to 160°; and just before the evaporation is completed and the sugar is ready to be run off, the temperature is reduced to 145°, or the lowest temperature at which proof-sugar, or concentrated sirup, boils at 3 inches below a perfect vacuum. When this point is arrived at, which is ascertained by withdrawing a sample by means of the proof-stick, another measure of sirup is added, and the process is repeated until the whole charge is admitted.

At each successive addition, the crystals increase in size, those first formed serving as nuclei. The process of crystallization is completed by drawing off the proof-sugar, which consists of the highly concentrated sirup, in which a great number of small crystals are floating, into the heater, which consists of an open pan with a steam-heated jacket, where the sirup is heated to 180° and stirred with wooden paddles to promote granulation.

The Rillieux vacuum-pan (patented August 26, 1843, and December 10, 1846) is of cast-iron, and cylindrical in form; it is used in trains of either three or four pans, and has given great satisfaction. It is the invention of N. Rillieux, of New Orleans. The juice is clarified, filtered, and then led into the back part of the first pan, a stop-cock in the pipe regulating the flow. A pipe from the front part of the first pan leads to the back part of the second pan, the flow being similarly regulated. The same as to the third pan, in which the juice reaches a gravity of 28° Beaumé, and from whence it is drawn by a pump and discharge into a second defecator; it thence goes to the filters, and, being conducted to the fourth pan, is there boiled to the point of granulation. A partial vacuum is maintained by the exhaustion of the vapor from the domes above the pans. The vapors from the first pan pass to the steam-coil in the second and last pan, and heat the juice therein; that from the second into the coil in the third; and that from the third and fourth into the condenser; the hollow columns and connecting-pipes being the means of communication. When a train of three pans is used, the second one is dispensed with. The water of condensation is removed, and disposed of according to its quality, whether the produce of boiler-steam or of sirup-vapor.

The application of a steam-jet to produce the necessary vacuum is shown in "Ewbank's Hydraulics," page 495, edition of 1853.

Fig. 6888.




*Vacuum-Pan.*

In that shown by Fig. 6888, the pan *a* is of copper, and has a cast-iron jacket *b*, with arrangements for admitting steam between the two. It contains a coil of copper pipe *c*, through which steam is passed for the purpose of boiling the juice, and has a flanged dome *d*, connected to it by bolts. *e* is a measuring-vessel, containing about 35 gallons, which is connected with the juice-vat by a pipe *e'*, and with the pan by a pipe *f*, each provided with suitable cocks; a cock, *f'*, in the top, admits air. The pan is connected by a pipe with the condenser, which is provided with a coil, through which the steam passes and serves to partially evaporate the juice, which, in its turn, condenses the vapors from the pan, and forms a partial vacuum therein. The pan and vessel *e*, being put into communication, a partial vacuum is formed in the latter, and, on turning the cock *e'*, the juice ascends into the measure, whence it is drawn into the pan, closing *e'*, opening *f f'*, and allowing atmospheric pressure to act. *s* is an overflow-vessel, for catching any sirup which may boil over from the pan.

*h h* are gages for ascertaining the quantity of liquid in the measuring and overflow vessels; *i*, a mercurial gage, for indicating the amount of the vacuum. *i'*, a thermometer; *k* is a man-hole, for obtaining access to the interior of the pan, and *l* the proof-stick, for ascertaining the progress of the boiling and granulation. *m* is a valve, for admitting steam to the worm, and *n*, a smaller valve, admitting steam into the interior of the pan for cleansing. *o* is one of the two windows through which the progress of the operation may be viewed. The sugar is run out of the pan by depressing a gun-metal saucer *p*, fitted to the discharge-opening *q*, at the base of the pan, and raised or lowered by the lever *r*. In some cases, a cock is substituted for the saucer.

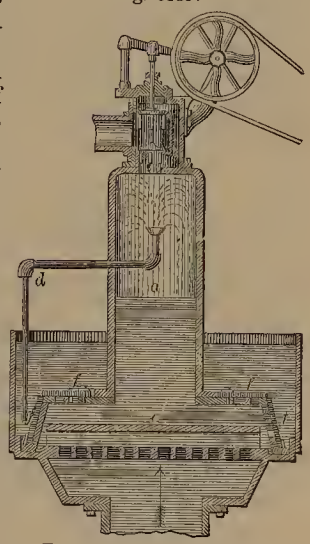
Connected with the boiler and the pan is an expansion-vessel, for reducing the pressure of the steam to the point required in the pan.

In Tooth's apparatus, the juice, at the moment of granulation, is pumped down through a rose at the top of the vacuum-pan, and thus distributed in streams through the air contained therein, exposing a much larger surface for evaporation. The evaporating-chamber is an elongated cylinder, having a top and bottom like that of the ordinary round pan. The juice, on its way to the chamber, passes through a number of pipes in a steam-heated cylinder.

**Vac'u-um-pump.** (*Steam-engine.*) 1. A pump used for withdrawing the air from a boiler or chamber, in order that it may be filled with water forced in under atmospheric pressure. It is employed in connection with marine engines.

2. A pump in which the condensation of steam is availed of to produce a vacuum for the purpose of raising water.

Fig. 6889.




*Burdon's Vacuum-Pump.*

In Burdon's (Fig. 6889), the steam is admitted into the chamber *a* through puppet-valves automatically operated by connection with the engine, forcing out any water which may be contained therein through the eduction-valves *f*, which cover a number of ports in the top and sides of the larger lower chamber. On coming in contact with the more expanded water-surface in this lower chamber, the steam is partly condensed, causing a partial vacuum, and allowing the water to flow through the pipe *d* into the upper chamber, where it is discharged in the form of spray, occasioning the total condensation of the steam, which closes the steam induction-pipe and raises the gravitating valve *c*, which covers a large number of openings in the bottom of the chamber through which the water rises. A fresh influx of steam then takes place, and the operation is continuously repeated.

Cameron's consists of a spiral tube partly filled with mercury and surrounding a central tube, having a partition in its middle, an induction-valve at each end, and an eduction-valve near each end. The ends are journaled in hollow boxes connected with tubes leading to the well or cistern, and by rotating the apparatus alternately in reverse directions, a vacuum is produced at one end, causing a flow of water into one end of the pipe and a plenum at the other, by which water already received in that end is expelled.

See also PULSOMETER; STEAM VACUUM-PUMP.

Huffer, in his patent, No. 37,344, January 6, 1863 (reissued August 25, 1874), claims the use of exhaust steam from an engine to condense in a vacuum-chamber, and so raise water to turn a wheel.

**Vac'u-um-valve.** A reversed safety-valve, opening inwardly to the pressure of the atmosphere when there is a negative pressure in the boiler.

**Vad'mel.** A coarse frieze of the Orkney Islands. WADMAREL.

**Vag'i-nal Spec'u-lum.** (*Surgical.*) An instrument for distending the vagina to expose its walls and the mouth of the uterus. See SPECULUM.

**Vag'i-nal Syr'inge.** (*Surgical.*) An instrument for injecting or irrigating the vagina. There are several forms; the ordinary cylindrical-shaped barrel with an opening in its hemispherical end.

One form has a distending cylinder and an interior rose for a spray or jet. A form in which the jet is backward and outward, etc. See SYRINGE.

**Vak'ka.** A large canoe of the Friendly Islands, used with an outrigger.

**Val'ance.** 1. The drooping ledge at the parting of a trunk.

2. A curtain depending from a horizontal frame and screening the space beneath.

3. A *lambrequin*, or drooping curtain hiding the curtain-rods of a window.

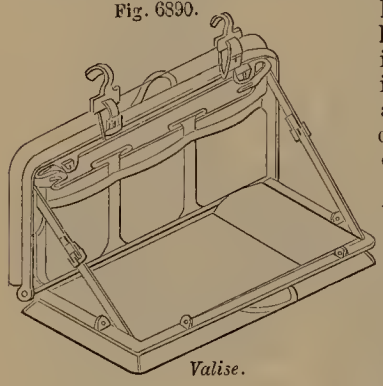
**Va-len'ci-ennes' Lace.** A variety of lace, whose meshes are of the form of an irregular hexagon. It is formed of two threads, partly twisted and plaited at top of the mesh. The pattern is worked in the net.

**Va-len-tin's' Knife.** A knife with two parallel blades for making thin sections for microscopic objects.

**Va-let' a Pa-tin'.** (*Surgical.*) The ligature-forceps. It has two hinged branches, approached or separated by a screw or running ring. Used for seizing vessels that are to be tied. See also TENACULUM-FORCEPS.

**Va-lise'.** 1. (*Military.*) A cylindrical portmanteau of leather, 18 inches long, is placed on the saddle of each off-horse of an artillery-carriage, and is used for carrying the smaller articles of the driver's personal equipment.

Fig. 6890.



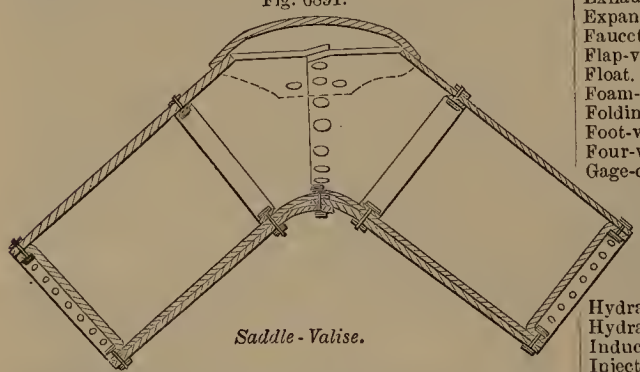
*Valise.*

2. A small trunk or portmanteau, to hold a traveler's equipment for short journeys.

Fig. 6890 shows one which may be hooked up in a tent to form a shelf.

Fig. 6891 is a cylindrical valise, to fit behind the cantle of a saddle.

Fig. 6891.

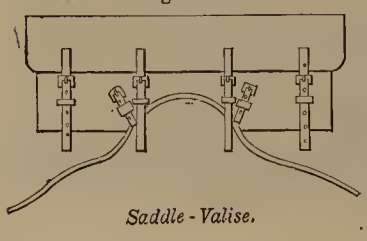


*Saddle-Valise.*

**Va-lise'-lock.** A small trunk-lock.

**Va-lise'-sad'dle.** A valise-saddle is placed on each off-horse of an artillery-carriage. It is used for carrying the driver's valise, but may be employed for riding on in case of necessity.

Fig. 6892.



*Saddle-Valise.*

Fig. 6892 shows a valise made hollowing beneath, for this purpose. It has side-fastenings and straps attached to the lower portion.

**Val'ley.** (*Building.*) The internal angle formed by the junction of two inclined sides of a roof.

**Valve.** A lid, cover, leaf, ball, box, disk, plug, or plate, lifting, oscillating, rotating, or sliding in connection with a port or aperture, so as to permit or prevent the passage of a fluid through the port which it guards.

Valves are of several classes.

1. *Rotary;* such as *cocks*, *faucets*, *throttle-valves*.
2. *Lifting;* raised clear of the seat by power beneath; such as *ball*, *conical*, *cup*, *safety*, *poppet*.
3. *Hinged;* such as *clack*, *butterfly*.
4. *Sliding;* such as the *slide*, D.
5. *Spring;* such as some forms of safety-valves.
6. *Inverted cup;* such as *quicksilver-valve*, *air-trap*, etc. *Cornish*.
7. *Key;* such as those of the *organ*, *flute*, etc.

Other names are derived from peculiar shape, application, mode of actuation, function, etc.

See under the following heads:—

Alarm-check valve.
Annular valve.
Automatic valve.
Back-pressure valve.
Balanced feed-valve.
Balanced slide-valve.
Balanced valve.
Ball-cock.
Ball-valve.
Bib-valve.
Blow-through valve.
Blow-valve.
Brine-valve.
Bucket-valve.
Butterfly-valve.
Check-valve.
Chimney-valve.
Clack-valve.
Clapper-valve.
Cock.
Communication-valve.
Cone-valve.
Conical valve.
Core-valve.
Crown-valve.
Cup-valve.
Cut-off valve.
Cylindrical valve.
Delivery-valve.
Discharge-valve.
Disk-valve.
Double-beat valve.
Double-seat valve.
D-valve.
Equilibrium-valve.
Escape-valve.
Exhaust-valve.
Expansion-valve.
Faucet (varieties; see FAUCET).
Flap-valve.
Float.
Foam-cock.
Folding-valve.
Foot-valve.
Four-way cock.
Gage-cock.
Globe-cock.
Globe-valve.
Governor-valve.
Grease-cock.
Gridiron-valve.
Hanging-valve.
Hydrant-valve.
Hydraulic valve.
Induction-valve.
Injection-valve.
Interual safety-valve.
Key-valve.
Kingston's valve.
Lever-valve.
Lock-up safety-valve.
Long-slide valve.
Main-check valve.
Measuring-faucet.
Meter-valve.
Molasses-gate.
Mud-valve.
Oil-cup.
Organ-valve.
Oscillating-valve.
Pet-cock.
Pipe-valve.
Piston-head valve.
Piston-valve.
Plug-valve.
Pneumatic valve.
Pnematic-tube valve.
Pot-lid valve.
Priming-valve.
Pump-valve.
Puppet-valve.
Purging-cock.
Quicksilver-valve.
Regulation-box.
Relief-valve.
Reverse valve.
Rotary-valve.
Safety-valve.
Screw-down valve.
Sea-cock.
Segmental valve.
Self-acting valve.
Slide-valve.
Sluice-valve.
Snifting-valve.
Spherical valve.
Spring-balance valve.
Spring-valve.
Starting-valve.
Steam-heater valve.
Steam-regulator valve.
Steam-valve.
Stop-cock.
Submarine valve.
Suction-valve.
Sweetening-cock.
Syringe-valve.
Tail-valve.
Test-cock.
Three-way cock.
Throttle-valve.
Tidal valve.
Trap-valve.
Tripping-valve.
Trunnion-valve.
Two-way cock.
Vacuum-valve.
Valve-bucket.
Valve-cock.
Valve-coupling.
Valve-file.
Valve-gear.
Valve-motion.
Water-check.
Water-closet valve.
Water-gate.
Wicket.

The heart is constructed upon the principles of hydraulics, and is furnished with a valve.

Harvey deduced the circulation of the blood from Aquapendente's discovery of the *valves* in the veins. Servetus, who was burnt at Geneva, 1553, was engaged in the search, and came near anticipating the theory which Harvey completed in the following century. See PULSOMETER, page 1825; SPHYGMOMETER, page 2265.

Fig. 6893 is a caoutchouc pump-valve, which opens to allow

Fig. 6893.

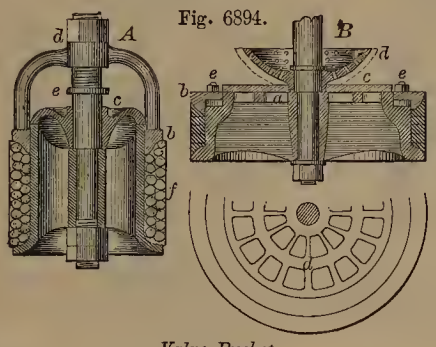
*Perreaux's Pump-Bucket Valve.*

water to pass upward as the bucket descends, and closes as the bucket rises. It may have been suggested by the *mitral* valve of the heart.

**Valve-buck'et.** (*Hydraulics.*) A bucket provided with a valve; the bucket or sucker of a pump. In *A*, the valve *c* slides upon the bucket-rod, its upward movement being limited by the stop *c*; *b* is a ring having an attached fork, which is pressed down by the nut *d* and serves to tighten the packing *f*.

*B* is of brass, and is formed with a grid *a* on top; the ring *b* by which the packing is adjusted is pressed down by screws *e e*; the valve *c* is a disk of vulcanized rubber, strengthened by canvas, which slips easily round upon the grid, so as not to strike always on the ribs in the same part; *d* is a perforated gun-metal guard, against which the valve strikes as the water passes through the bucket.

Fig. 6894.



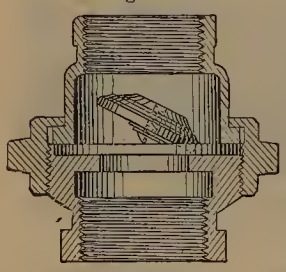

*Valve-Bucket.*

**Valve-cham'ber.** (*Hydraulics and Steam.*) A chamber in which a pump or steam-valve works. See list on previous page.

See PUMP; STEAM-ENGINE; etc.; and list under VALVE.

**Valve-cock.** A form of faucet in which the closure of the passage is by a valve on a seat. See COCK; FAUCET; etc.

Fig. 6895.



*Valve-Coupling.*

**Valve-coup'ling.** A pipe-coupling which includes a valve-plate, as in Fig. 6895. Between the faces of the coupling is interposed a circular disk of leather with a segmental piece taken out, so as to leave a central circular portion attached to one side, which forms a stop-valve, the concentric portion of the same forming a packing.

**Valve-file.** A file with two acute and two obtuse angles; used in filing *valve* and *key ways*, grooves for *fins*, *feathers*, *splines*, etc.

Fig. 6896.

*Valve-File.*

**Valve-gear.** The combination of mechanical devices through which the valves of a steam or other engine are operated.

These are shown in the various engines to which they are specially applied. See CUT-OFF; LINK-MOTION; STEAM-HAMMER; STEAM-PUMP; PORTABLE ENGINE; CORNISH ENGINE; DRAINING-ENGINE; STATIONARY ENGINE; OSCILLATING-ENGINE; etc. See list under STEAM-ENGINE; and also list under VALVE.

The first means for shutting and opening the passages in the pipes of steam-engines were cocks, as we see in Worcester's, Papin's, Savery's, and Newcomen's; and these were all worked by hand and required close attention. A boy named Humphrey Potter being in charge of the cocks of one of Newcomen's pumping-engines, and desiring time for play (it is said), managed to fasten the lever-handles of the spigots by means of rods and string to the walking-beam of the engine, so that each recurrent motion of the beam effected the change required. This was the first automatic valve-motion, and was afterward improved by Beighton, in 1717. See LINK-MOTION, etc., and list under STEAM-ENGINE.

**Valve-seat.** (*Steam.*) The flat or conical surface upon which a valve rests.

**Vamp.** The part of a boot or shoe upper in front of the ankle seams.

**Van.** 1. A large covered wagon.

2. A shovel used in sifting ore. A peculiar rocking motion is given to the shovel, separating the ore powder into grades of varying gravity. This is called *vanning*.

**Va-na'di-um.** (Equivalent, 68.6; symbol, V.) A rare, white, brittle, very infusible metal, not known in the arts.

**Vand-kik'kat.** A form of water-telescope invented in Norway, and used for viewing submerged objects.

**Vane.** 1. A device attached to an axis, and having a surface exposed to a moving current of fluid, so as to be actuated thereby.

To indicate *direction of motion*, as in a weather-cock or anemoscope.

Or *rate of motion*, as in an anemometer or velocimeter.

Or *amount* of fluid passing, as in a water-meter.

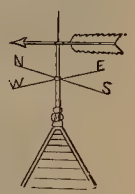
Or to obtain *power*, as in a smoke-jack or windmill.

2. Conversely: a blade, paddle, wing, float, or spiral flange attached to an axis, by whose rotation the motion of the fluid of submergence is obtained in the fanning-mill, blower, liquid meter, or spiral pump.

Or by which a body is moved, as with the paddle-wheel or propeller.

3. A target or sight.

Fig. 6897.




*Wind-Vane.*

Hence:—

1. *a.* A *weather-cock*, flag, or arrow, or other thin object, which points in the direction whence the wind proceeds. It has an unequal surface exposed to the action of the wind on the respective sides of the vertical axle on which it oscillates as the wind veers. See ANEMOSCOPE; ANEMOMETER; WIND-GAGE.

A *dog-vane* is one placed on the weather side of the quarter-deck to show the steersman the direction of the wind. It is usually made of cork, stuck with feathers, and suspended by a string from a staff.

*b.* The arm of a windmill against which the wind acts. See WINDMILL.

2. A board on the arm of a fan, fly, or upon a rotating axis.

Fig. 6898.

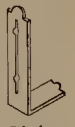
*Staff-Vane.*

*a.* The *wing* of a fanning-mill, winnowing-machine, or blower, which impinges upon and drives the air. See FAN; BLOWER; WINNOWING-MACHINE; etc.

*b.* The thread or extended spiral flange of a screw-propeller, which impinges upon the water and impels the vessel.

3. (*Surveying.*) *a.* A *staff-vane*, or surveyor's target, is a horizontal piece of wood, slipping on a leveling-staff, and having an aperture through which the graduations on the staff are observed. It is raised or lowered to any point on the staff, to indicate the plane of apparent level at which it is cut by the axis of the telescope. See also Fig. 2913.

Fig. 6899.



*Sight-Vane.*

*b.* The sight of a quadrant or similar instrument for the measurement of angles. It is a piece of brass standing perpendicularly to the plane of the instrument. The *foresight-vane* is opposite to the *fore* horizon-glass; the *backsight-vane*, to the other glass.

**Van-fosse.** (*Fortification.*) A wet ditch at the outer foot of the glacis.

**Vang.** (*Nautical.*) A rope, one on each side, to steady laterally the peak of a gaff. It is usually a *pendant*, with a *twofold purchase*.

**Van'ning.** An operation for testing the quality of auriferous sand, or of ore when stamped.

A portion of the powder or slime is immersed in water, and shaken to and fro in a shovel till the agitation and the action

of the water with the occasional removal of the coarse matter of the top enable the rich collection at the bottom to be examined and its approximate value estimated.

The shovel is concave-bladed, is 14 inches long, 13 inches wide, pointed, and has a handle 4 feet long.

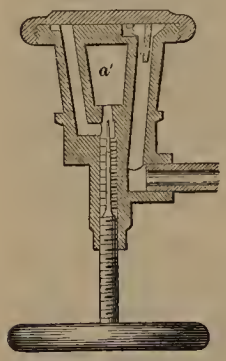
**Va'por-a'ri-um.** (*Surgical.*) A vapor-bath.

**Va'por-burn'er.** A device for burning previously vaporized liquid hydrocarbons. It has a metallic portion, which is so heated by the flame as to vaporize the liquid passing through it.

It is used in lamps, and in heating and cooking stoves. In Fig. 6900, the expanded cap is exposed to the flame in $a'$, and has a channel inside running around near its circumference with connecting grooves.

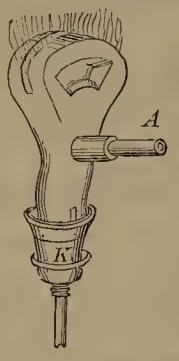
In Fig. 6901, the retort or generator has two jaws with circuitous passages in which the liquid is vaporized. The oil enters by a lateral pipe $A$, passes through the jaws, down to the foot of the stem, and the vapor passes upward, and is ignited between the jaws. The adjustable collar $K$ regulates the supply of atmospheric air to the vapor.

Fig. 6900.




*Vapor Lamp-Burner.*

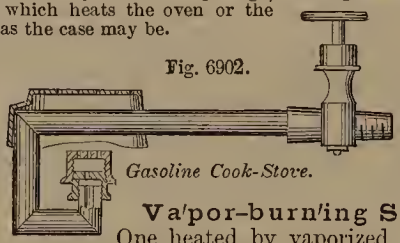
Fig. 6901.




*Generator for Vapor-Lamps.*

Fig. 6902 is an adaptation to cooking and heating stoves. The oil is heated and vaporized in its passage, and is ignited beneath the plate which heats the oven or the chamber, as the case may be.

Fig. 6902.



*Gasoline Cook-Stove.*

**Va'por-burn'ing Stove.** One heated by vaporized hydrocarbon. See VAPOR-BURNER.

**Va'por-en'gine.** See STEAM-ENGINE; AËRO-STEAM-ENGINE; ALCOHOL-ENGINE; AMMONIA-ENGINE; GAS-ENGINE; etc.

In 1850, a French inventor, M. Prospère Vincent du Trembley, brought into notice what is now known as the "binary vapor-engine," or the "combined vapor-engine." He constructed a number of these engines, and published a work describing their peculiarities and their operation, — "Manuel du conducteur des machines a vapeur combinées ou machines biuaires," Lyons, 1850.

In this class of engines, one cylinder has its piston impelled by steam, usually, and the fluid, having done its work there, is exhausted into another part of the apparatus, where it is allowed to communicate its unutilized heat to some liquid volatile at a lower temperature; and the vapor of this second liquid, by its expansion in a second cylinder, yields additional useful work. Ether, chloroform, and carbon bisulphide, or, as the latter is popularly termed, bisulphide of carbon, have all been tried without permanent success. Du Trembly used the vapor of ether.

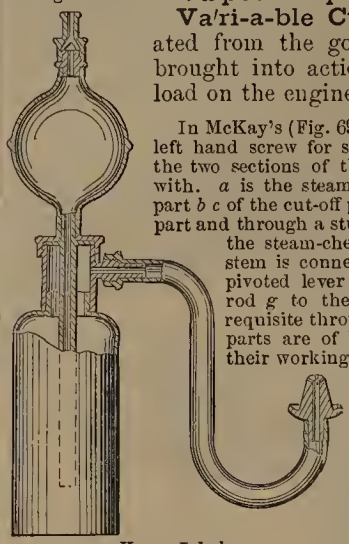
The vapor of heated bisulphide of carbon has been used as a motor, and its tendency to absorb the lubricant in the cylinder may be rectified by adding to the bisulphide a certain quantity of oil, which will pass over with the vapor. Ellis's patent. See BISULPHIDE-OF-CARBON ENGINE.

**Va'por-in-hal'er.** (*Surgical.*) One for administering vapor produced by drawing or forcing atmospheric air through a liquid, or a sponge saturated with a liquid.

In Fig. 6903, air is forced through the tube into the liquid by contraction of the bulb, and is ejected from the nozzle, whose pipe communicates with the space above the liquid.

**Va'por-iz'ing-stove.** One for furnishing steam to dampen the air of apartments, conservatories, etc. It has usually a gas, oil, or alcohol lamp beneath a pan of water.

Fig. 6903.



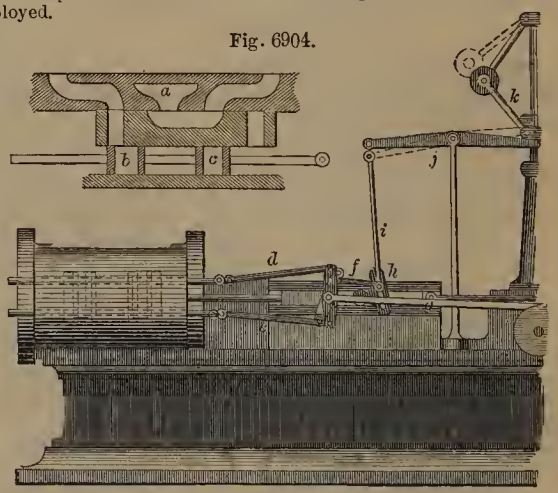
*Vapor-Inhaler.*

**Va'por-lamp.** See VAPOR-BURNER.

**Va'ri-a-ble Cut-off.** One actuated from the governor, so as to be brought into action according to the load on the engine. See CUT-OFF.

In McKay's (Fig. 6904), the usual right and left hand screw for spreading or approaching the two sections of the cut-off are dispensed with. $a$ is the steam-valve; the stem of each part $b$ $c$ of the cut-off passes through the other part and through a stuffing-box at each end of the steam-chest, and the end of each stem is connected by a rod $d$ $e$ to the pivoted lever $f$, itself connected by a rod $g$ to the eccentric; by this the requisite throw is produced. The two parts are of box form, or hollow on their working faces, so as to be always balanced. The link $h$ is connected by the rod $i$ and lever $j$ to the collar of the governor $k$; it is connected to a block sliding in the same guides as the lever $f$, and moves with it, serving to tilt it, and, through the medium of the rods $d$ $e$, bringing the two parts of the cut-off together to diminish the steam supply, or spreading them to increase it, according as the governor-balls spread out or collapse. Other forms than the ball-governor may be employed.

Fig. 6904.

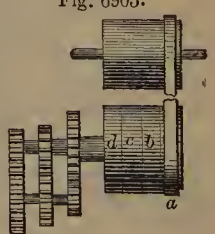



*Variable Cut-Off.*

**Va'ri-a-ble-speed Pul'ley.** Arrangements of pulleys and gearing for transmitting different speeds are shown in the accompanying illustrations.

Fig. 6905 is for transmitting three different speeds. The right-hand pulley $a$ is a loose one. The next pulley $b$ is fast to the shaft which carries the smallest cog-wheel. The tubular shaft of the next pulley $c$ is sleeved on the central shaft, and runs the middle cog-wheel. The shaft of the third pulley $d$ is an outer sleeve, and is fast to the largest cog-wheel. By slipping the band on to one or the other of the fast pulleys, variable speeds are communicated to the lower cog-wheel shaft, as relative sizes of the pairs of wheels will indicate.

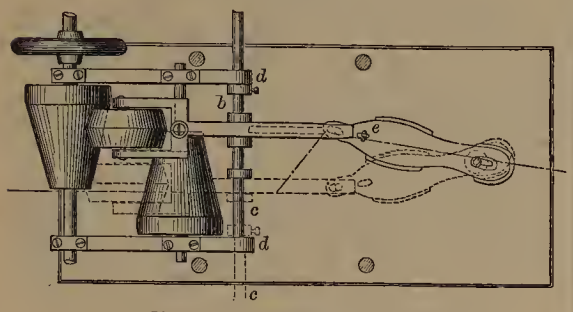
Fig. 6905.




*Variable-Speed Pulleys.*

Olmsted's (Fig. 6906) is designed for controlling the speed of light machinery, particularly sewing-machines. The idler-pulley $a$ is journaled in a swinging frame, and is brought into frictional contact with the cone-pulleys $b$ $c$, the former of which is the driver and the latter the follower, by depressing the treadle $d$; a spring or weight raises the idler out

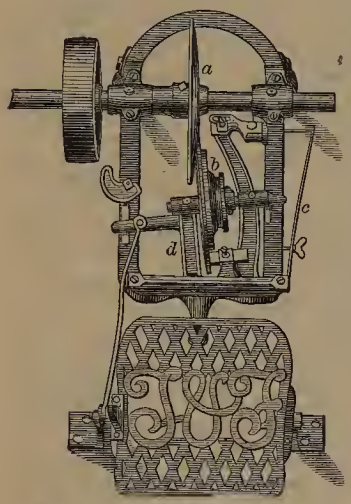
Fig 6906.




*Olmsted's Variable-Speed Pulley.*

of gear with the pulleys *b c*. The doubly conical form of the idler *a* causes it always to have an equal bearing on the cone-pulleys when in gear, and by shifting the treadle and swinging frame to the right or left, the relative velocities of the driving and driven cone pulleys may be varied as desired.

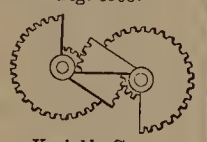
Fig. 6907.




*Wright's Variable-Speed Pulley.*

Wright's variable-speed attachment (Fig. 6907), for sewing-machines, etc., consists of two disks *a b* with slightly rounded faces; the former is placed on the driving-shaft, and the latter runs in a frame which swings slightly. When in normal position, the face of the driving-disk *a* bears near its center, against the face of the disk *b*, driving it at the lowest rate of speed. On swinging the frame, by the treadle or otherwise, the distances of the contacting points of the two disks from their centers are varied to produce different speeds.

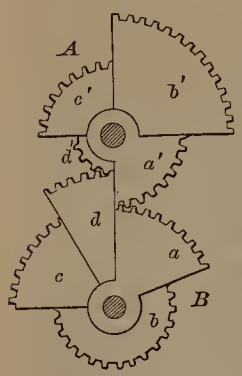
Fig. 6908.



*Variable Gears.*

**Va'ri-a-ble-speed Wheel.** A contrivance for obtaining alternately accelerated and retarded circular motion.

Fig. 6909.




*Variable Gears.*

Each wheel has three cogged portions of varying radii, which mesh with counterpart portions of the opposite wheel. While the *driver* has a regnlar speed of rotation, three rates of motion are imparted to the *driven*-wheel, according to the radii of the portions in contact at different times.

In another form, each wheel has four cogged sectors; the section of extreme range being divided by those of medium and equal radii. The sectors are arranged on different planes, and the velocity imparted is proportioned to the relative radii of the parts in contact.

Thus, in Fig. 6909, in the two compound gear-wheels *A B*, the respective segments *a a*, *b b*, *c c*, and *d d* mesh together, an arrangement by which four different rates of speed may be obtained, either *A* or *B* being used as the driver, or double that number, in case they alternately perform this function.

**Va-ri-a'tion-com'pass.** A compass designed for observing the magnetic bearings of celestial objects in order to determine the deviation of the magnetic needle from the true meridian.

The angular difference between the magnetic bearing of a circumpolar star when at its greatest eastern or western elongation and its polar distance gives the deviation directly; but any celestial object may be employed, its true bearing being readily calculated when its declination and the latitude of the place are known. At sea the sun is the object commonly observed. See AZIMUTH-COMPASS.

In a more restricted sense, a compass provided with a long needle, which oscillates in a graduated circle, and has appliances for measuring and reading the small diurnal changes in the magnetic variation.

Variation or declination is the horizontal angle which a needle makes with the meridian.

The changes of declination are of three kinds.

1. *Secular.* That which takes place in cycles. At London, in 1550, the variation was 11° 17′ E.; about 1660 it was 0°. It then began to deviate to the west till it attained its maximum in 1815, 24° 17′ 18″. In 1865 it was 20° 38′.

2. *Annual.* This was first remarked at Paris by Cassini.

3. *Diurnal.* First remarked at London, by Graham, 1722. The changes are greatest in summer, least in winter. The needle declines toward the west from 8 A. M. till 2 P. M., and then to the east till 8 or 9 P. M. See MAGNETOMETER.

The variation of the compass was known to the Chinese philosopher, Keon-tsoung-chi, in the twelfth century. He determined it to be from 2° to 2° 30′ at Pekin. The French savans who formed part of the plundering host at Pekin a few years since, found time, after participating in the scramble for *loot*, to test the correctness of the former observation. They found it to be about the same. What their ancestors were about in the twelfth century may be seen by reading the lives of the Capets. The same century saw 25 popes ruling in Rome.

Gerbert, Alhazen, and Roger Bacon relieve that and neighboring centuries of their dreariness.

The Chinese mode of suspending the needle was by a silken string, the most delicate which has yet been devised, and the one adopted at the magnetic observatories which are acting in concert in so many parts of the world. See COMPASS.

The variation of the compass was again noticed by Columbus in 1492, and Sebastian Cabot in 1540.

The western line of no variation was discovered by Columbus in 1492, about 100 miles west of the Azores. It has since shifted.

"Columbus has not only the incontestable merit of having first discovered a 'line without magnetic variation,' marking a memorable era in nautical astronomy, but also of having, by his considerations on the progressive increase of westerly declination, in receding from that line, given the first impulse to the study of terrestrial magnetism in Europe.

"We know positively from the Chinese 'Penthsaayan,' which was written under the dynasty of the Song between 1111 and 1117, that the manner of measuring the amount of westerly declination had been then long understood. That which belongs to Columbus is not the first observation of the existence of the variation (which, for example, is noted in the map of Andrea Bianco, in 1436), but the remark which he made on the 13th of September, 1492, that 2½° east of the island of Corvo the magnetic variation changes, passing from N. E. to N. W." —HUMBOLDT.

"The first variation-compass was constructed before 1525, by an ingenious apothecary of Seville, Felipe Guillen. So earnest were the endeavors to learn more exactly the direction of the curves of magnetic declination, that in 1585 Juan Jayme sailed with Francisco Gali from Manila to Acapulco for the sole purpose of trying in the Pacific a declination-instrument which he had invented."

"The cosmographer Alonso de Santa Cruz, one of the instructors of Charles V., undertook the drawing up of the first general 'Variation Chart,' although indeed from very imperfect observations, as early as 1530, or a century and a half before Halley.

"The 'movement' of the magnetic lines, the first recognition of which is usually ascribed to Gassendi, was not even yet conjectured by William Gilbert; but at an earlier period Acosta, 'from the information of Portuguese navigators,' assumed four lines of no declination upon the surface of the globe. Hardly had the inclinometer, or dipping-needle, been invented in England by Robert Norman, in 1576, than Gilbert boasted that by means of this instrument he could determine the position of a ship in a dark and starless night."

Pope Alexander VI adopted the line of no variation discovered by Columbus 100 miles west of the Azores, as the easterly limit of the papal grant to the Spaniards, May, 1493. He was not aware, no blame to him, that the line was slowly moving east, and would soon be far removed from its first-observed position. It was reserved for a future age to show the incorrectness of the then received opinion that "magnetism is an effluvium issuing forth from the root of the tail of the Little Bear."

Halley, in 1683, sketched his theory of four magnetic poles or points of attraction, and of the periodical movement of the magnetic lines of no variation. In 1698–1702 he made several voyages of observation, and the result was a general "variation-chart," in which the points of equal variation were connected by curved lines.

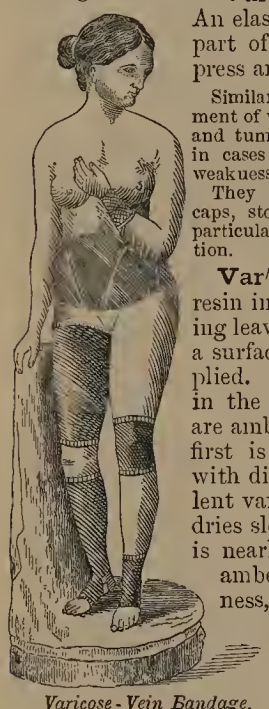
Hansteen's chart (1787) gives the western and eastern lines of no variation at the date of his writing. These are given under MAGNETOMETER (which see).

Variation-charts are now in common use at sea. An excellent one, derived from the most recent observations, is published from time to time by the British Admiralty.

Before chronometers had attained their present excellence, and lunar observations were commonly practiced, it was proposed to determine the longitude at sea from the variation of the compass; but owing to the difficulty of its being accurately determiued from such an unstable observatory as a ship's deck, and from other causes, this method was found to have no practical value.

**Var'i-cose Stock'ing.** Elastic hose to compress and support distended veins in the leg and foot. See next article.

Fig. 6910.



*Varicose-Vein Bandage.*

**Var'i-cose-vein Band'age.** An elastic bandage applied to any part of the body in order to compress and retain varicose veins.

Similar bandages are used in the treatment of weak, swollen, or ulcerated limbs, and tumors, and for supporting the body in cases of corpulence and of abdominal weakuess.

They are termed anklets, belts, knee-caps, stockings, etc., accordiug to their particular function aud place of application.

**Var'nish.** A solution of gum or resin in oil or spirit, which in drying leaves a smooth hard coating on a surfacc to which it has been applied. The gums principally used in the preparation of oil-varnishes are amber, animè, and copal. The first is hard, tough, and soluble with difficulty; it makes an excellent varnish, but is expensive, and dries slowly. Animè dries quickly, is nearly as hard and insoluble as amber, but is deficient in toughness, is liable to crack, and turns dark on exposure to air and light. Copal is next in durability to amber, and the paler kinds when made into varnish become lighter on exposure; it is morc largely uscd than any other gum in preparing oil-varnishes, animè being frequently added to impart drying properties.

Mastic is a soft rosin; it may be mixed with spirits of wine or turpentine, formiug a brilliant varnish, which flows readily and works easily; it may be removed by friction with the hand, and is hence used for pictures and other delicate works. Dammar is softer than mastic, with which it is sometimes mixed, forming a clear eolorless varnish, suitable for maps, etc.

Common rosin, dissolved with the assistance of heat in linseed-oil or turpentine, is used as a varnish for soue common purposes, and is mixed with other varnishes to impart brilliaucy, but unless sparingly used renders them liable to crack. Lac and sandarach form the bases of most spirit-varnishes; they are dissolved in strong alcohol, and applied to articles which are uot exposed to the weather.

Linseed-oil boiled with substances for clarifying and imparting drying properties is the usual vehicle for oil-varnishes.

The general mode of preparation is nearly the same for all. The oil is boiled in a *set pot* in a masonry or brickwork furnace, and is gradually poured upon the guu while in a state of fusion in the *gum-pot*, the mixture being constantly stirred during the process. Brass or copper wire sieves having about 40 meshes to the inch are used for straining the ingredients. Thc turpentine is afterward added while hot, and thoroughly iucorporatcd by stirring, and thc varnish strained into proper vessels, which are set by to allow it to become clarified. A moderate degree of heat only should be employed during thc process, too great heat rendering the varnish sticky and injuring its flowing properties. In preparing spirit-varuishes on a large scale, a still may be advantageously employed. Thc gum and spirit are mixed, and sufficient heat applied to cause a gentle boil. Thc spirit which distills over is afterward combiued with the varnish.

Subjoined are some of the recipes employed: —

*Amber.* 1. *a.* Gum amber (fused), 6 pounds; hot elarified linseed-oil, 2 gallons. Boil until it *strings* well, aud when somewhat cooled add 4 gallons spirits of turpentine. To make it dry quicker, boiled oil may be used, or dryers may be added during the cooling.

*b.* Amber, 4 ounces; pale boiled oil, 1 quart. Proceed as before.

*c.* Pale transparent amber, 5 ouuces; clarified, or pale boiled oil and turpentine, each 1 pint.

2. *Bessemer.* Pale copal varnish, 1 part; turpentine, 6 parts; agitate with about $^1/_{30}$ part of dry slaked lime. After standing a few days, it is drawn off; 5 parts of this, and 4 of bronze powder form Bessemer gold-paint.

3. *Black amber varnish* (used by coach-makers). Melted amber, 1 pound; drying oil, hot, ½ pint; black rosin, powdered, 3 ounces; Naples asphaltum, 4 ounces. Incorporate, and when partially cooled, add turpentine 1 pint.

4. *Black iron-work.* Fused asphaltum, 48 pounds; boiled oil, 10 gallons; red lead and litharge, each 7 pounds; white copperas, dried aud powdered, 3 pounds. Boil for 2 hours, and add hot linseed-oil, 2 gallons; dark gum amber, fused, 8 pouuds. Boil about 2 hours longer, until a drop of tho mass may be rolled, when cool, into a pill; then withdraw the heat and stir in 30 gallons turpentine.

5. *Black Japan.* *a.* Naples asphaltum, 50 pounds; dark gum animè, 8 pounds. Fuse; add linseed-oil, 12 gallons; boil as before; add dark gum amber 10 pounds, fused and boiled with 2 gallons linseed-oil; add dryers, aud proceed as before.

*b.* Burnt umber, 8 ounces (ground in oil); asphaltum, 4 ounces, dissolved in heated oil. Mix, and add what remains of 1 gallou boiled oil; boil, and thin with turpentine.

*c.* Litharge, 4 parts; boiled oil, 87; spirits turpentine, 2; red lead, 6; umber, 1; gum-shellac, 8; sugar of lead, 2; white vitriol, 1. All the ingredients, except the turpentine and a small quantity of the oil, are boiled together for 5 hours, continually stirring; the oil is added from time to time to allay frothing, and the turpentine is mixed in when the varnish is nearly cool.

6. *Body.* *a.* Best African copal, 8 pounds; drying oil, 2 gallons; turpentine, 3½ gallons. Made like amber varnish.

*b.* Pale gum copal, 8 pounds; clarified oil, 2 gallons; sugar of lead, ½ pound; turpentine, 3½ gallous. Proceed as before, and mix whilc hot with a varnish composed of pale gum animè, 8 pounds; linseed-oil, 2 gallons; white copperas, ¼ pound; turpentine, 3½ gallons. The mixture is immediately strained into vessels. This varnish is used on carriage bodies; it dries in about 4 hours in summer, and 6 in winter.

7. *Bookbinders'.* Gum sandarach, 3 ounces; rectified spirit, 1 pint. Dissolve cold, frequently stirring.

8. *Carriage.* *a.* (*Spirit*, for interior work.) Gum sandarach, 1¼ pounds; pale shellac, ¾ pound; clear pale rosin, ½ pound; alcohol (specific gravity, .8220), 3 quarts. Dissolve, and add pure Canada balsam, 1½ pounds. Dries in 10 minutes or less.

*b.* (*Oil.*) Pale African copal, 8 pounds. Fuse; add clarified linseed-oil, 2½ gallons. Boil until striugy, and add dried copperas and litharge, each ¼ pound. Again boil, thin with 5½ gallons turpentine, and mix with a varnish composed of gum animè, 8 pounds; clarified linseed-oil, 2½ gallons; dried sugar of lead and litharge, each ¼ pound. Boil as before, and thin with turpentine.

*c.* (*Second quality.*) Gum animè, 8 pounds; clarified oil, 3 gallons; litharge, 5 ouncs; dried and powdcred sugar of lead and white copperas, eaeh ¼ pound. Proceed as before, and thin with turpentine, 5½ gallons.

9. *Chinese.* Mastic and sandarach, each 2 ounces; alcohol, 1 pint. Dries in 6 miuutes.

10. *Copal.* *a.* Pale hard copal, 2 pounds. Fusc, boil with 1 pint drying oil, and thin with turpeutine.

*b.* Copal melted, dropped into water, and dried, 3 to 4 ounces. Powder, and add in small quantities at a time to 1 pint turpentine, hcated in a water-bath.

*c.* (*Japanner's Copal.*) Pale African copal, 7 pounds; drying oil, ½ gallon; turpentine, 3 gallons. Proceed as in *a.*

*d.* (*Spirit.*) Copal, prepared as above, 4 ounces; gum sandarach, 6 ounces; mastic, 2 ouuces; pure Chio turpentine, 3 ounces; powdered glass, 5 ounees; alcohol, 1 quart. Dissolve by gentle heat.

*e.* Coarsely powdered copal and glass, each 4 ounces; camphor, ½ ounce; alcohol, 1 pint. As above.

11. *Crystal.* *a.* Pale Canada balsam and rectificd spirits of turpentine, equal parts. Used for drawings, tracing and transfer paper.

*b.* Mastic, 3 ounces; alcohol, 1 pint. For pencil-drawings.

12. *Flexible* (also called *balloon* or *caoutchouc* varnish). *a.* India-rubber, in small pieces, 1½ ounces; chloroform, ether (washed), or bisulphide of carbon, 1 pint. Dissolved cold.

*b.* Dried white copperas and sugar of lead, each 3 ouncs; litharge, 8 ounces; linsced-oil, 1 gallon. Boil until stringy, cool slowly, and draw off thc clear portiou; if too thick, add drying oil.

*c.* India-rubber, 1 ounce; drying oil, 1 quart. Dissolve by heat.

13. *Furniture.* White wax, 1 part; spirits turpentine, 4.

14. *Gilder's.* Pale lac, in grains, gamboge, dragon's blood, and annotta, each 12½ ounces; saffron, 3¼ ounces. Each gum is dissolved separately in 5 pints alcohol, and the annotta and saffron are separately infused in a like quantity of alcohol. The ingredients are mixed to form any particular tint desired.

15. *For gun-barrels.* Shellac, 1½ ounces; dragon's blood, 3 drams; alcohol, 1 quart. Applied after browning.

16. *Lac Varnish.* *a.* Seed lac or shellac, 8 ounees; alcohol or naphtha, 1 quart.

*b.* Pale shellac, 5 ounces; borax, 1 ounce; water, 1 pint.

Digest at nearly the boiling-point until dissolved, and strain. Used for water-colors, inks, etc.; when dry, it is waterproof.

*c.* (*Lacquer for brass-work, etc.*) Turmeric (ground), 1 pound; alcohol, 2 gallons. Macerate for 1 week, strain by expression, and add gamboge, 1½ ounces; pale shellac, ¾ pouud; gum sandarach, 3½ pounds. Straiu, and add turpentine-varnish, 1 quart.

Other lacquers arc prepared in a similar way from alcohol and shellac, a solution of the coloring ingredients, as dragon's blood, gamboge, etc., being kept on haud and added to produce auy required tint.

16. *Mahogany.* Gum animè (sorts), 8 pounds; litharge and sugar of lead (powdered and dried), each 4 ounces. Prepare as in "body" varnish, and thin with turpentine.

17. *Mastic.* Pale gum mastic, 5 pounds; pounded glass, 3 pounds; turpentine, 2 gallons. Put iu a round vessel aud roll until dissolved.

18. *Oak* or *wainscot.* *a.* Clear pale rosin, 3½ pounds; turpentine, 1 gallon.

*b.* Add to the above 1 pint Canada balsam.

19. *Patent leather.* 1st coat. Pale Prussian blue (containing alumina), 5 ounces; drying oil, 1 gallon. Boil to the eonsistency of single size. When cold, grind with a little vegetable black. 2d coat. A little more Prussian blue is added to the above. 3d coat. The oil is boiled until stringy, and a little pure Prussian blue and vegetable black are added. The last coat, or finishing varnish, is similarly prepared, but contains ½ pound pure dark Prussian blue and ¼ pound pure vegetable black per gallon; a little copal or amber varnish is often added.

20. *Spirit.* *a.* (*Brown hard.*) Gum sandarach, 3 pounds; pale shellac or seed lac, 2 pounds; alcohol, 2 gallons. Dissolve, and add turpentine-varnish, 1 quart. Agitate well, strain, allow it to stand for a month, and draw off the clear portion.

*b.* (*White, hard.*) Gum sandarach, 5 pounds; camphor, 2 ounces; coarsely pounded glass, 3 pouuds; alcohol, 7 quarts. After straining, add 1 quart Canada balsam.

*c.* (*Soft, brilliant.*) Sandarach, 6 ounces; elemi, 4 ounces; animè, 1 ouuce; camphor, ½ ounce; alcohol, 1 quart. Proceed as before. Gum benzoin, balsam peni, balsam tolu, oil of lavender, or essence of musk or ambergris may be added to impart a scent.

21. *Transfer.* Mastic and sanderach, each 4 ounces. Dissolve in 1½ pints alcohol, and add Canada balsam, ½ pint.

22. *Wax.* *a.* Pure white wax, 1 pound. Melt with a gentle heat; add warm spirit of specific gravity .830, 1 pint. Mix thoroughly, and grind to a paste on a slab with a muller, adding more spirit, as required; the paste is then made into an emulsion with 3½ pints water in a marble mortar. Used as a varnish for paintings. When dry, it is equally heated by passing a hot iron over its surface, or otherwise, and after cooling, is polished with a lineu eloth.

*b.* (*For Furniture.*) Wax, 5 ounces; spirits of turpentine, 1 quart.

23. *French Polish.* Gum sandarach, 14 ounces; shellac, 14 ounces; gum mastic, 7 ounces; alcohol (specific gravity, 0.8295), 7 pints. Pulverize the gums, and effect their solution by agitatiou, without the aid of heat. For porous woods, 7 ouuces Venice turpentine are added.

24. *Shellac Varnish.* 2½ ounces shellae, coarsely pulverized; 1 pint alcohol. Keep in a warm place for a few days, frequeutly shaking it until the gum is dissolved; strain.

25. *Bookbinder's Varnish.* Dissolve 5 ounces shellae in 1 quart alcohol; boil a few minutes with 10 ounces of recently heated animal charcoal; if not then perfectly colorless, add a little more charcoal. When colorless, strain through silk, and afterward filter through blotting-paper. If wanted perfectly pure, strain when cold.

26. *Colored Spirit-Varnish*, for coating brass and other alloys. 2 parts seed lac, 4 sandarach, 4 elemi, 40 alcohol.

Alcoholic solutions of gummi-gutta, and dragon's blood, or fuchsin, picric acid, martins yellow, and coralline, are separately prepared and added to the above in quantities ascertained by trial to impart the desired color.

To remove the marks left by the brush, and to impart luster, varnish, after drying, is polished. This is effected by first rubbing with powdered pumice and water, and uext with an oiled rag and tripoli until the desired polish is produced. The surface is afterward dried with a soft linen cloth; any greasiness is removed by means of powdered starch, and the process is finished by rubbing with the hand.

Great care must be takeu that the surface to which varnish is applied be free from grease or smoke, which prevents all oil-varnishes from drying.

Varnish of excellent quality was made in ancient Egypt, and in some cases has retained its brightness during the lapse of thirty centuries.

They baked their varnish on clay, with a moderate heat, we may suppose. It does not appear that they had any true glaze. That came from China many a long year after. See GLAZE; POTTERY.

The Chinese are said to make varnish by beating together fresh blood with quicklime, which is extensively used as a coating for wooden articles which they wish to make completely water-tight. Von Scherzer, who first introduced this substance to the uotice of Europeans, says he has seen in Pekin wooden chests that had been varnished with it, which, after a journey over Siberia to St. Petersburg and back, were still sound and perfectly water-tight. Eveu baskets of straw used for the transportation of oils are made fit for the purpose by means of this varnish. Pasteboard coated with it becomes, both in appearance aud firmness, like wood. Articles requiring to be absolutely impervious are varnished twice, or at the most three times, by the Chinese.

See also LACQUER.

**Var'nish-ing.** (*Photography.*) The protection of a finished photographic negative by flooding it with a solution of resin in alcohol or benzole, whereby it receives a hard, glossy surface, and is able to stand the wear and tear of printing.

**Var'nish-lens.** A small lens made by putting a drop of copal on a flat piece of oiled glars. It congeals into a plano-convex lens.

**Vase.** A large cup or open-mouthed jar, with handles.

The ample variety of Egyptian forms may be understood when it is said that the moderu teapot form, the large oil-jar, the China vase, the common pitcher, the water-ewer, the ale and wine glasses, the flower-glasses, the drinking-goblet, the beaker, and the bowl are all to be seen iu Egyptian paintings. Analysis and observation prove that the Etruscan and Campanian pottery included most kinds now known, including porcelain, and that they had glazes of glass, lead, and salt. Of the Athenian vases some are fluted, some of a jet black, and others a bright red. The Corinthians had a heavy coarse black ware. That of Athens was the lightest and most elegant, that of Sicyon the brightest and most ancient. The Greeks had also pink vases with black silhouettes.

The Barberini or Portland vase is the largest and best preserved specimeu of ancient paste glass. The figures represent the nuptials of Thetis and Peleus.

For a treatise on vases, see Fosbroke's "Eucyclopædia of Antiquitics," I. 233-243.

See also Rawlinson's "Five Great Empires," Vol. I. 389-391.

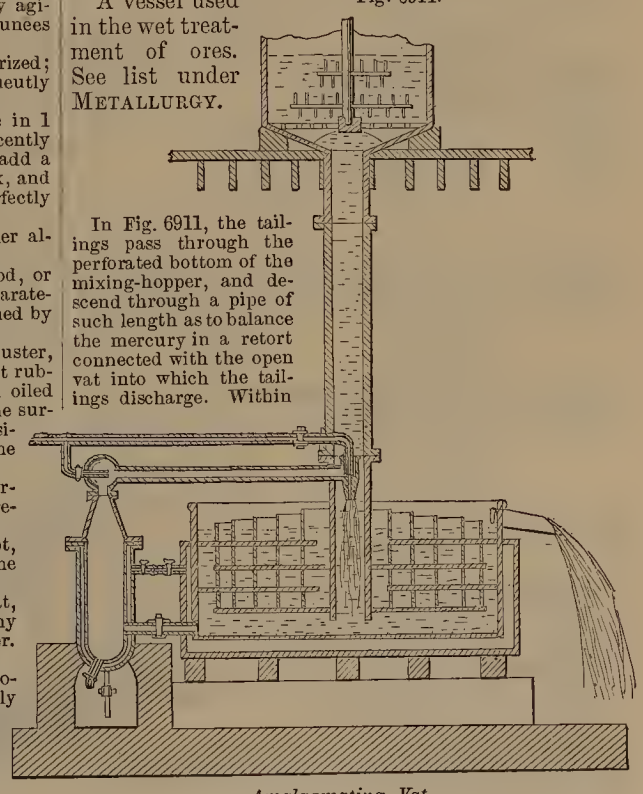
**Vat.** A wooden tub; used for many purposes, such as for *mash, wash, hop-liquor*, in brewing and distilling. Also known as a *back.*

As a mere storage vessel, it is a CISTERN or TANK (which see).

Also used in many chemical and manufacturing operations in which the substances used are boiled, soaked, steeped, lixiviated, elutriated, etc. See STARCH; TANNING; etc.

Fig. 6911.

A vessel used in the wet treatment of ores. See list under METALLURGY.



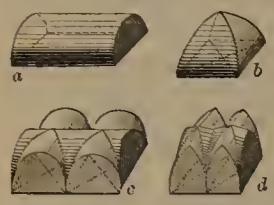
In Fig. 6911, the tailings pass through the perforated bottom of the mixing-hopper, and descend through a pipe of such length as to balance the mercury in a retort connected with the open vat into which the tailings discharge. Within

*Amalgamating-Vat.*

the vat is a series of horizontal and vertical concentric perforated copper partitions, which force the contents to take a devious course. The vat and retort are surrounded by steam-jackets. The fumes of mercury are injected into the descending body of the tailings within the pipe.

**Vault.** (*Architecture.*) A passage or room with an arched ceiling. An extended arch covering an apartment.

Fig. 6912.




*Vaults.*

Vaults are *cylindrical*, *coved*, or *groined*.

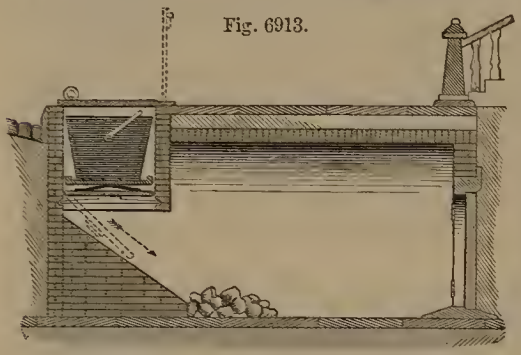
1. A cylindrical vault has a semicircular arch (*a*).

2. A coved vault has an arch which springs from all sides of its plan (*b*).

3. A *groined* arch is one formed by two intersecting vaults (*c*, *Roman* groined vault; *d*, *Gothic* groined vault).

The pavement-sidewalks of cities are, to a large extent, used as coal-cellars. Fig. 6913 shows a garbage-box set within

Fig. 6913.

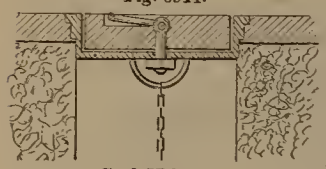


*City Vault, with Coal-Chute and Garbage-Box.*

a pit in the sidewalk. The cover of the pit is a lid, and the floor is hinged, so that it may be opened when delivering coals into the vault.

**Vault-cov'er.** A lid over a hole through a pavement. The hole may have a movable cover, to be removed, as in Fig. 6914, when coal is to be emptied into the vault; or it may be for light or ventilation, or both.

Fig. 6914.



*Coal-Hole Cover.*

Fig. 6915 is a vault-cover with glass bull's-eyes or prisms. Between the lights of Fig 6916 are congeries of pyramidal elevations, whose intervening depressions drain into gutters in the belly of each corrugation.

Fig. 6915.

*Vault-Cover.*

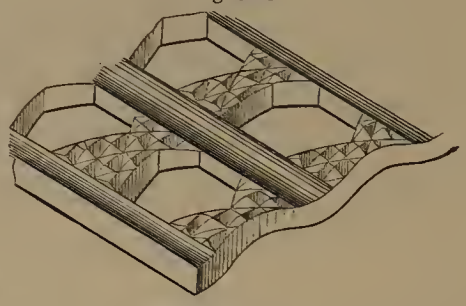
**Vault'ing.** *Vaultings*, or arched roofs, are *supported* by *ribs* or *groins*, often intersecting each other, meeting in a *boss* in the center, and frequently springing from *corbels*, *brackets*, etc.

**Vault'ing-horse.** A wooden horse in a gymnasium, for practice in vaulting. Mentioned by Vegetius; common in ancient times.

**Vault-light.** A cover for a pavement coal-hole, or a section of sidewalk; partially glazed, to illuminate the vault beneath.

In Fig. 6917, the glass panels in the vault-cover have a grooved upper surface and an under surface composed of a series of rounded parallel ridges of unequal depth, with intervening rounded valleys.

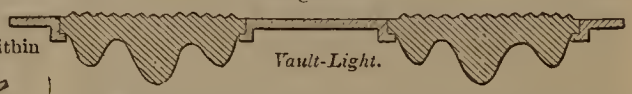
Fig. 6916.



*Vault-Cover.*

In Fig. 6918, the inverted metallic girders have intervening elongated glasses, the lines of junction being covered with strips to exclude moisture and secure the glasses in place.

Fig 6917.



*Vault-Light.*

In McCormack's, the sections of the circular vault-cover are alternately open and glazed with lenses. The cover is adjustable above a lower circle, partly glazed and partly open, so as to bring the light sections into coincidence and leave ventilating openings, or close the latter.

**V-bob.** A form of bell-crank, used to change the direction of motion, as the horizontal motion of the cross-head of a steam-engine to the vertical motion of a pump-rod working in a mine-shaft.

**V-croze.** (*Coopering.*) One formed for cutting an angular heading-groove.

**Vec'tis.** (*Surgical.*) An obstetric lever.

**Veg'e-ta-ble-chop'per.** One for cutting roots, etc., for stock.

Fig. 6920 consists of a row of blades on the under side of a vertically oscillating lever. The knives are bolted to a plate which is secured to the lever, and work into a segmental trough in which the vegetable or meat is placed. A spring beneath the lever raises the knives, which have a length nearly equal to the width of the trough in which they operate.

Fig. 6918.

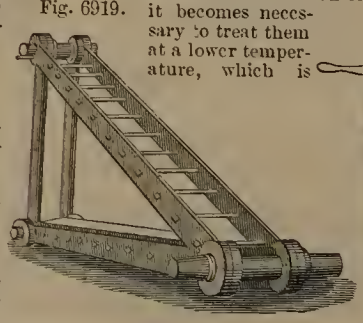
*Vault-Light.*

**Veg'e-ta-ble-cut'ter.** One for slicing or chopping roots or leaves, as potatoes, cabbage, etc. See ROOT-CUTTER; etc.

**Veg'e-ta-ble-ex'tracts Ap'pa-ra'tus.** This apparatus consists of means for partial grinding and then boiling or steaming the materials to extract the juices; followed by presses for separating the liquid from the fibrous and cellular portions of the plant.

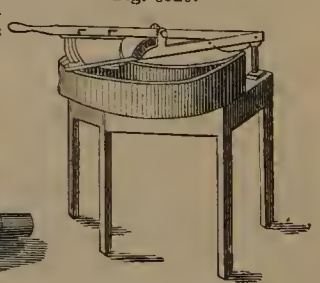
Sometimes a common boiler is used to condense the liquid and bring the extract to the desired consistence; but in order to avoid the destruction or modification of some juices it becomes necessary to treat them at a lower temperature, which is

Fig. 6919.



*V-Bob.*

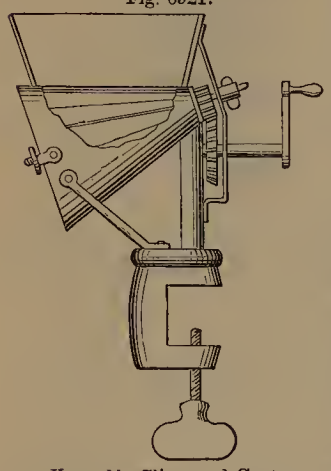
Fig. 6920.



*Vegetable-Chopper.*

done by means of a VACUUM-PAN (which see). This ingenious device has attained its principal celebrity in boiling the juice of the sugar-cane, but is not unknown in the laboratory. Its essential principle consists in withdrawing a portion of the atmospheric pressure, so as to lower the boiling-point.

Fig. 6921.



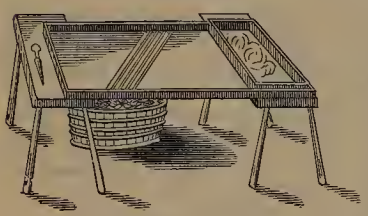
*Vegetable Slicer and Grater.*

**Veg'e-ta-ble-flan'nel.** A fabric made of a fine fiber obtained from the leaves of the *Pinus sylvestris*. *Pine-wool.*

**Veg'e-ta-ble-grat'er.** A machine for pulping roots or leaves.

Fig. 6921 is for cutting or grating. The vegetable in the hopper is exposed to the action of the knives on the inner rotary cone; the knives are adjusted to regulate the thickness of the slices. A grating-cone may be substituted for the cutting-cone. See also ROOT-GRINDER, page 1976.

Fig. 6922.



*Sauerkraut-Machine.*

**Veg'e-ta-ble-i'vo-ry.** The nut of a species of South American palm (the *Phytelephus macrocarpa*), much used in turnery. The nuts are known in commerce as *Corosso nuts.*

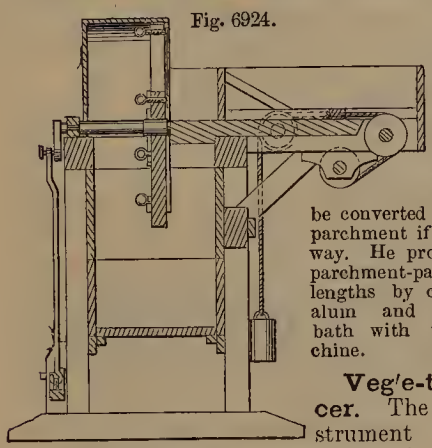
**Veg'e-ta-ble-parch'ment.** A substance produced by immersing unsized paper in sulphuric acid diluted with about one half its volume of water. Remaining acid is neutralized by an alkali. This closes the pores of the paper, producing apparently a change in its molecular constitution without chemical alteration, and the product closely resembles animal parchment both in its appearance and properties. *Papyrine.* SEE PARCHMENT-PAPER.

Fig. 6923.

*Vegetable-Slicer.*

Mr. Colin Campbell treats the paper with a strong solution of alum, and dries it thoroughly, before dipping in the acid. The alum prevents the action of the acid from being so rapid as before, and renders the whole operation more manageable. Paper which has been printed on can be converted into vegetable-parchment if treated in this way. He proposes to make parchment-paper in endless lengths by connecting the alum and sulphuric-acid bath with the paper-machine.

Fig. 6924.



*Vegetable-Slicer.*

**Veg'e-ta-ble-sli'cer.** The German instrument for cutting cabbage-heads for sauer-kraut consists of a table with several blades inserted over oblique slits in the table, and projecting slightly above its general surface. The pith of the stalk having been removed by a scoop or suitable knife, the cabbage-head is pushed back and forth over the knives, the shreds falling through the slits in the table into the tub below. The cut cabbage is salted down and seasoned. See also ROOT-CUTTER.

Fig 6923 is a smaller household implement, for slicing cucumbers, potatoes, apples, etc.

Fig. 6924 is a machine in which the vegetables are advanced by a weighted follower against a series of knives in a wheel which is rotated in a plane at right angles to the root-trough. See also VEGETABLE-CUTTER; ROOT-CUTTER.

**Veg'e-ta-ble-wash'er.** See ROOT-WASHER, page 1976.

**Ve'hi-cle.** A car or other conveyance. See under the following heads: —

*Varieties of Vehicles.*

Accelerator.
Ambulance.
Army-wagon.
Artillery-carriage.
Barouche.
Barrow.
Basket-carriage.
Basterna.
Bath-chair.
Bathing-machine.
Battery-forge.
Battery-wagon.
Berlin.
Bicycle.
Bier.
Boat-car.
Bob-sled.
Bob-sleigh.
Booby-hut.
Booby-hutch.
Break.
Brett.
Brick-truck.
Britzska.
Brougham.
Buck-wagon.
Buggy.
Cab.
Cabriolet.
Calash.
Caleche.
Camion.
Car (varieties; see CAR).
Caravan.
Cariole.
Caroche.
Carriage.
Carryall.
Cart.
Casemate-truck.
Chair. Bath
Chaise.
Chaise-cart.
Chariot.
Chariotee.
Child's carriage.
Clarence.
Coach.
Corf.
Coupé.
Curricle.
Cutter.
Dan.
Dearborn.
Dennet.
Diligence.
Dog-cart.
Drag.
Dray.
Droitska.
Drosky.
Dummy-car.
Dumping-car.
Dumping-cart.
Dumping-sled.
Dumping-wagon.
Earth-car.
Fiacre.
Fire-engine.
Float.
Fly.
Fourgon.
Gig.
Gill.
Ginny-carriage.
Gladstone.
Glass-carriage.
Glass-coach.
Go-cart.
Gun-carriage.
Hack.
Hack-barrow.
Hackery.
Hackney-coach.
Hand-barrow.
Hand-car.
Hand-cart.
Hansom.
Hearse.
Horse-litter.
Hose-carriage.
Hose-reel.
Ice-boat.
Ice-carriage.
Ice-chair.
Jaunting-car.
Jumper.
Jump-seat.
Kellach.
Kibitka.
Ladder-carriage.
Landau.
Landaulet.
Liquid-manure cart.
Litter.
Locomotive-chair.
Log-sled.
Lorry.
Lumber-wagon.
Mail-coach.
Manumotor.
Mortar-wagon.
Night-cart.
Noddy.
Omnibus.
Outside-car.
Palanquin.
Perambulator.
Petroleum-cart.
Phaeton.
Pilentnm.
Pony-chaise.
Post-chaise.
Railway-car.
Refrigerating-car.
Revolving-car.
Road-locomotive.
Rockaway.
Sailing-carriage.
Sedan.
Sled.
Sledge.
Sleigh.
Sling-cart.
Sociable.
Spring-wagon.
Stage.
Stanhope.
Steam-carriage.
Street-sprinkling cart.
Stretcher.
Sulky.

Tender.
Tilbury.
Tim-whiskey.
Tip-sled.
Tram.
Treuch-cart.
Tree-remover.
Trolley.
Truck.
Tumbril.
Vau.
Velocipede.
Victoria.
Vis-a-vis.
Wagon.
Wagonette.
Wain.
Water-barrow.
Wheelbarrow.
Wheel-chair.
Wind-car.

*See also Tools, Appliances, and Parts of Vehicles.*

Arm.
Axle.
Axle-adjuster.
Axle-arm.
Axle-box.
Axle-clamp.
Axle-clip.
Axle-coupling.
Axle-gage.
Axle-guard.
Axle-hook.
Axle-lathe.
Axle-lubricator.
Axle-nut.
Axle-settiug machine.
Axle-skeiu.
Axle-teleseope.
Axle-tree.
Body.
Body-loop.
Bolster.
Bolster coupling.
Bolster-plate.
Bow.
Bow-iron.
Box.
Box-axle.
Brace.
Bracing-chain.
Brake.
Breeching-hook.
Buggy-top.
Bushing.
Butting-ring.
Cab.
Calash-top.
Carriage-bolt.
Carriage-coupling.
Carriage-guard.
Carriage-jack.
Carriage-lock.
Carriage-maker's tools (see WOOD-WORKING TOOLS, etc.).
Carriage-seat.
Carriage-shackle.
Carriage-spring.
Carriage-step.
Carriage-top.
Carriage-wheel.
Cart-ladder.
Circle.
Clip.
Clout.
Compound axle.
Coupling-pin.
Coupling-pole.
Cuttoo-plate.
C-spring.
Detaching horses from vehicles.
Dickey.
Dish.
Double-tree.
Draft-bar.
Drag.
Dress-guard.
Duledge.
Equalizing-bar.
Evener.
Fare-box.
Felloe.
Felloe-boring machine.
Felloe-coupling.
Felloe-dressing machine.
Felloe-sawing machine.
Fifth wheel.
Foot-iron.
Fore-carriage.
Futehell.
Gather.
Gear.
Hammer-cloth.
Hay-rack.
Head-block.
Hind carriage.
Hobby.
Hold-back hook.
Hood.
Hood-quarter.
Houuds.
Hub.
Hub-borer.
Imperial.
Journal-box.
Kiugbolt.
Kuee.
Lazy-back.
Limber.
Linch-pin.
Loop.
Loop-holder.
Nave.
Neck-yoke.
Perch.
Pole.
Pole-crab.
Pole-pad.
Pole-prop.
Pole-tip.
Prop.
Prop-joint.
Rave.
Reach.
Rein-holder.
Rubber.
Rub-iron.
Runuer.
Runniug-gear.
Saud-board.
Shaft.
Shifting-rail.
Shoe.
Siugle-tree.
Single-tree hook.
Skein.
Skid.
Slat.
Slat-iron.
Sled-brake.
Sled-knee.
Sled-runner.
Sled-truck.
Sleigh-bell.
Sleigh-brake.
Sleigh-runner.
Sleigh-shoe.
Slider.
Sloates.
Sole.
Spindle.
Splash-board.
Splinter-bar.
Spoke.
Sprcader.
Spring-bar.
Spring-head.
Spring-seat.
Standard.
Stay-chain.
Stem.
Step.
Step-cover.
Straddling-spokes.
Strake.
Stretcher.
Swing.
Swingle-tree.
Tail-board.
Thill.
Thill-coupling.
Thill-jack.
Thimble-skein.
Thorough-brace.
Tilt.
Tire.
Tire-bender.
Tire-heater.
Tire-shrinker.
Tongue.
Tongue-chains.
Top-block.
T-plate.
Trace-hook.
Treble-tree.
Tree.
Tree-coupliug.
Tree-irons.
Turuing-plate.
Unloading attachment for wagons.
Wagon-brake.
Wagon-drag.
Wagon-dumping.
Wagon-hammer.
Wagon-jack.
Wagon-lock.
Wagon-seat.
Wagon-spring.
Wagon-tongue supporter.
Walking-vehicle.
Wheel.
Wheelwright's tools (see WOOD-WORKING TOOLS, etc.).
Whiffletree.
Whip socket.
Yoke.

**Vein.** (*Mining.*) *a.* A *lead* or *lode* of ore-bearing rock, *alive* or *dead;* that is, containing ore or not.

*b.* A seam of metalliferous matter filling up a former fissure in rock.

When the vein is straight and uniform, it is called *regular;* when it swells and contracts, it is called a *pipe-vein.* Such enlargements are *bunches.*

Small veins passing off from the ore to the rock are called *strings;* when very small, *threads.*

Veins of ore are classified under specific names, which vary in different localities. The following is a reasonably good scheme: —

1. *Rake-vein;* one commencing at the surface and proceeding downward in a more or less vertical direction. The *slope* is the *hade* or *heading* of the vein. The line of direction is the *bearing.*

2. *Pipe-vein;* an irregular, continuous body of ore, usually conformable to the strata between which it is insinuated. Its working forms an irregular cavern.

3. *Flat or dilated vein;* an extended layer of ore of varying thickness, lying between two strata.

4. *Interlaced vein;* having a lode, with a number of ramifying branches; the latter are known as *side-lodes, feeders, branches.*

Ore in *masses* is known as *nests, concretions, nodules, bunches.*

*Nests* are friable masses in pockets.

*Concretions* are kidney-shaped or tuberous.

*Nodules* are round, and frequently encrusted.

*Bunches* are masses of ore, surrounded by earthy minerals.

*Disseminated* metalliferous matter is dispersed in crystals, scales, globules, etc., in a large mass.

**Vein'stone.** (*Mining.*) The gangue or matrix of the ore. The *veinstone* frequently consists of crystalized silica, fluor spar, or carbonate of lime.

**Ve-linche'.** Sometimes called a thief-tube. A tube open at both ends, the lower orifice being so contracted that while the finger is closed upon the upper end, liquid will not issue from the lower. It is used in obtaining samples or small quantities of liquids from casks. Also known as a *sampling-tube,* or *sampler.*

Fig. 6925.

*Velinche.*

The *sucking-tube,* or *monkey-pump,* as sailors call it, is a straw or quill introduced through a gimlet-hole into a barrel, to draw the liquid therefrom. A rye-straw applied to a barrel of sweet cider is a familiar and agreeable illustration. It has also the merit — though it needs no extraneous recommendation — of being at least as old as Xenophon, who describes this mode of pilfering from the wine-jars of Armenia.

**Vel'lum.** A fine parchment made of calf-skin. The skins are limed, shaved, washed, stretched, scraped, and rubbed down with pumice-stone.

**Vel'o-cim'e-ter.** A measurer of speed. An *odometer* is ordinarily a measurer of distance, but by combining the element of time, it may become a *velocimeter.*

1. (*Nautical.*) The name is usually applied to the marine log, or speed-measurer. There are several different types.

*a. Pitot's tube* (see Metcalf's patent, No. 92,078, June 29, 1869); Elliott's tachometer, July 28, 1874. See also Fig. 1568, page 661. The principle is similar to the Lind *anemometer,* Fig. 205, page 99; the latter measures the speed, or force rather, of a current of air.

*b.* The *rotary-pump* principle. Walker, No. 68,265, of 1867.

*c.* The *log.* A chip on the end of the log-line or

train of wheels to register revolutions and consequent length of line out. Hotchkiss, No. 45,042, November 15, 1864; Lozier, No. 41,932, March 15, 1864; Barnaré, No. 93,513, August 10, 1869. See LOG.

*d. Vanes* actuated by current. St. John, No. 8,085, May 13, 1851; Pierce, No. 128,324, June 25, 1872.

*e.* A *flap-valve* opening against the current, and oscillated on its axis with a force proportionate to the speed of the vessel, actuating a rod and a poiuter on a dial. Walker, No. 14,328, February 26, 1856; Hinman and Tournier, No. 17,349, May 19, 1857; Thompson, No. 14,035, January 1, 1856.

A velocimeter, Vitruvius says (50 B. C.), was used by the *ancients*, and useful in his own time for indicating the distance traveled hy sea and hy land. The device for attachment to a land-carriage is described under ODOMETER (which see).

In navigation, an axle was placed athwart the vessel, having at each end a paddle-wheel four feet in diameter, which dipped into the water and was rotated hy the motion of the vessel. That part of the axle withiu the vessel had a wheel with a single tooth standing out beyond its face, at which place a box was fixed with a wheel inside it having 400 teeth corresponding to the single tooth of the before-mentioned wheel. On the side of the spur-wheel was another tooth, which at each revolution acted upon a horizontal wheel provided with balls, which, as they reached a channel, were dropped into a brazen vase, and made a sound, thus indicating by sound and by the number of balls dropped the number of Roman miles traveled. Four hundred revolutions of the paddles, 4 feet in diameter, was considered equal to 5,000 feet, — a Roman mile.

In Walker's apparatus for indicating the speed of vessels, the resistance of the water on the circumferential vanes causes the spindle to rotate, and motion is communicated, hy means of a worm-screw and pinion, to a train of wheels and indicator-hands within the cylinder, whereby the number of revolutions of the cylinder is registered, and the speed of the vessel approximately determined.

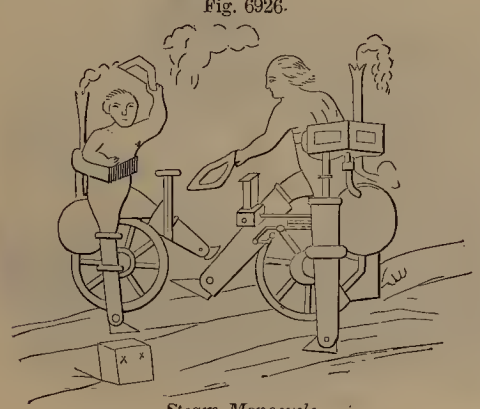
2. (*Machinery.*) Poncelet's velocimeter, for measuring the speed of machinery, etc., consists of a circular disk which is covered with card or paper, and caused to rotate with a uniform velocity by means of clock-work, while a pencil receiving its motion from that of the object whose speed is to be measured describes a curve upon the paper, varying according to the varying velocity of the object. See also SPEED-GAGE; SPEED-MEASURER; SPEED-RECORDER; SPEED-INDICATOR.

3. Apparatus for measuring rate of motion of cannon-balls. See ELECTRO-BALLISTIC APPARATUS; BALLISTIC PENDULUM; CHRONOGRAPH.

**Ve-loci-pede.** A species of carriage impelled by the rider. Blanchard and Magurier's velocipede was described in the "Journal de Paris," 1799. Known as the accelerator, 1819.

At the beginning of the century it was called a "dandy horse"; this was operated by the thrust of the feet on the ground. That of the Baron de Drais, invented at Mannheim, 1817, had but two wheels, and was moved by the thrust of the feet on the ground. Subsequently those driven by a crank movement connected with the wheels and operated by the hands through the medium of cranks or wheels were introduced.

Fig. 6926.



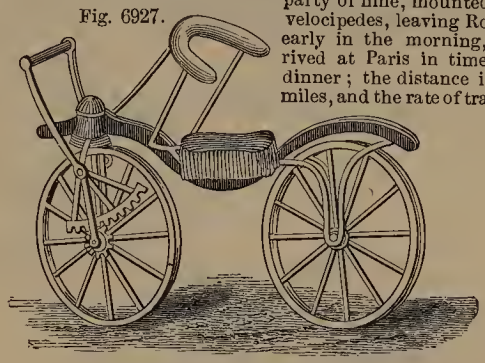
*Steam-Monocycle.*

The bicycle, patented in England by Johnson, was said to have been invented in Baden. Known in England as a *hobby*.

Subsequently, the bicycle, propelled by treadles operating cranks on the axles of the front wheel, and which created such a furore some six or eight years since, was introduced from France. Propulsion by treadles was applied to a three-wheeled velocipede hy McKenzie, as early as 1864; while the French bicycle of Lallemant was patented in this country in 1866. Numerous modifications and improvements followed, forming the subjects of patents, a list of some of which is appended.

The speed attained hy the swifter kinds of velocipedes averages from 12 to 13 miles an hour; 50 miles in 5 hours may he attained without the rider alighting from his vehicle; 123 miles within 24 hours has been aceomplished. On one occasion, a party of nine, mounted on velocipedes, leaving Rouen early in the morning, arrived at Paris in time for dinner; the distance is 85 miles, and the rate of travel, exclusive of stoppages, was hetween 10 and 11 miles an hour. Grades exceeding 1 in 25 are said to be impracticahle to the velocipede, and the rider in this case must dismount and lead his factitious steed, which, however, displays great docility on such occasions.

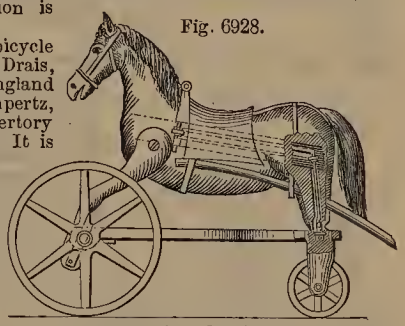
Fig. 6927.



*Baron de Drais' Velocipede.*

Fig. 6926, from Stewart's "Anecdotes of the Steam-Engine," puhlished in 1829, illustrates a sort of steam-monocycle; the mode of propulsion is not very obvious.

Fig. 6928.

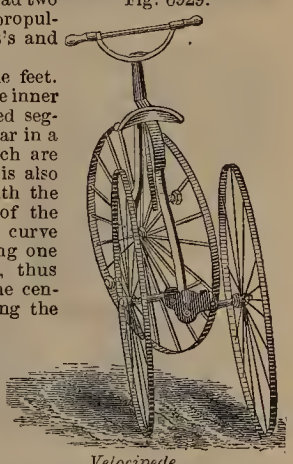


*McKenzie's Velocipede.*

Fig. 6927 is the bicycle of the Baron de Drais, as improved in England hy Louis Gompertz, shown in the Repertory of Arts in 1821. It is propelled hy a segment rack gearing in a pinion on the driving-wheel and operated hy a handle in front of the rider's seat or by the feet alternately touching the ground.

McKenzie's "cantering propeller" (Fig. 6928), patent, 1864, embraces "a cranked axle, arms and foot rest, so arranged that power applied hy the feet of the driver shall give motion to the vehicle." This, of course, had two front wheels, but the mode of propulsion is the same as in Lallemant's and other more recent bicycles.

Fig. 6929.



*Velocipede.*

Fig. 6929 is also driven hy the feet. The rear axle is in two parts, the inner ends of each formed into toothed segments which engage a small gear in a box, to which they and the reach are pivoted. The end of the reach is also a toothed segment engaging with the small gear. The inclination of the rider's hody when turning a curve partly rotates the gear, elevating one and depressing the other axle, thus inclining the wheels toward the center of the curve and facilitating the turning.

In Fig. 6930, the driving-wheel is operated by hand-cranks. To the stirrups for the rider's feet are attached cords leading to the two rear wheels, by which the machine is steered.

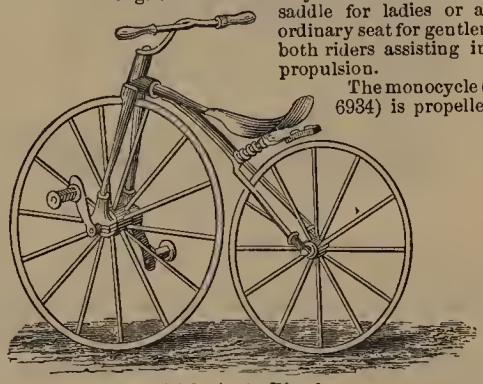
Pickering's (Fig. 6931) is a bicycle. The tiller is sufficiently elevated to permit a perfectly upright position in riding. The stirrups or crank-pedals are three-sided, and turn on the crank-pins, so that the pressure of the foot always brings one of the three sides into proper position, and are so shaped as to be operated by the fore part of the foot, bringing the ankle-joint into play and relieving the knee.

Fig. 6930.

*Velocipede.*

In Fig. 6932, the small rear wheel is only used as a point of support for the reach and for a friction-wheel. The driving-wheel, which is also the steering-wheel, is worked, not by direct connection of the feet with the treadles, but by the hands and feet, both through the medium of connecting-rods between the cranks and a walking-beam. The reach is so hinged that the wheel may be brought directly under the seat for attaining great speeds on level ground, or thrown forward when descending a slope. A pivotal arrangement permits of guiding the wheels to the right or left.

Fig. 6931.

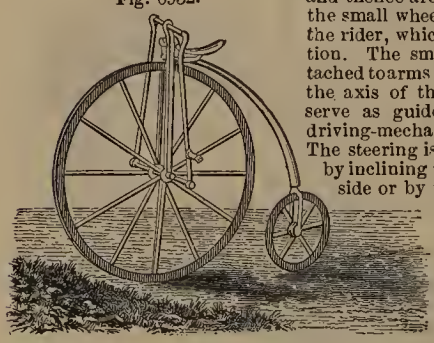


*Pickering's Bicycle.*

In Fig. 6933, the rear seat may be used either as a side-saddle for ladies or as an ordinary seat for gentlemen, both riders assisting in the propulsion.

The monocycle (Fig. 6934) is propelled by a hand-wheel, from which belts or ropes pass around pulleys on the axis of the main wheel, and thence around the axis of the small wheel, seen beneath the rider, which acts by friction. The small pulleys, attached to arms emanating from the axis of the main wheel, serve as guides to keep the driving-mechanism in place. The steering is effected either by inclining the body to one side or by touching a foot to the ground.

Fig. 6932.



*Bicycle.*

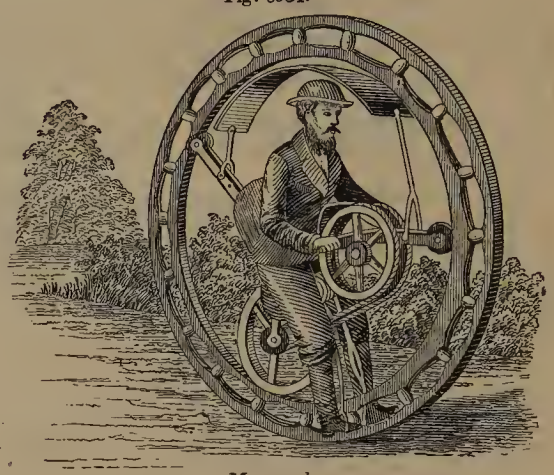
Fig. 6935 represents an ice-velocipede. It has a spiked driving-wheel in front, and two runners attached to the bottom of the reach behind.

Fig. 6936 illustrates a water-velocipede. The main wheel, which the driver bestrides, passing through a casing below, is the means of propulsion. The rudder is operated by two cords passing from the steering-bar beneath pulleys on each side to the rudder-head.

Fig. 6933.

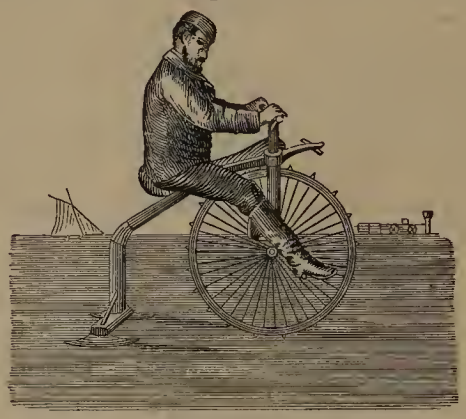
*Bicycle.*

Fig. 6934.



*Monocycle.*

Fig. 6935.



*Ice-Velocipede.*

*Patents on Velocipedes from* 1819 *to* 1868.

| No. | Name. | Date. |
|---|---|---|
| ——— | W. K. Clarkson | June 26, 1819. |
| ——— | G. Parker | November 21, 1825. |
| 19,092. | L. Kelner | January 12, 1858. |
| 30,192. | S. W. Barr | October 2, 1860. |
| 35,583. | H. Boyd | June 17, 1862. |
| 36,160. | A. Longett | August 12, 1862. |
| 41,310. | P. W. Mackenzie | January 19, 1864. |
| 44,256. | J. Goodman | September 13, 1864. |
| 46,705. | H. A. Reynolds | March 7, 1865. |
| 47,220. | W. Quinn | April 11, 1865. |
| 53,209. | J. G. Wilkinson | March 13, 1866. |
| 54,207. | H. A. Reynolds | April 24, 1866. |

Fig. 6936.

*Water-Velocipede.*

| No. | Name. | Date. |
|---|---|---|
| 59,915. | P. Lallemant | November 20, 1866. |
| 64,416. | F. G. Hoeppner | May 7, 1867. |
| 71,561. | C. A. Way | November 26, 1867. |
| 71,562. | C. A. Way | November 26, 1867. |
| 73,029. | M. Newman | January 7, 1868. |
| 74,058. | L. Deroyier | February 4, 1868. |
| 75,531. | W. G. Crossley | March 17, 1868. |
| 77,478. | O. F. Gleasou | May 5, 1868. |
| 79,553. | B. P Crandall | July 7, 1868. |
| 79,654. | Hanlon Brothers | July 7, 1868. |
| 80,425. | H. A. Reynolds | July 28, 1868. |
| 81,603. | A. Christian | September 1, 1868. |
| 82,319. | D. Hunt, Jr | September 22, 1868. |
| 83,035 | C. K. Bradford | October 13, 1868. |
| 83,696. | C. N. Cutter | November 3, 1868. |
| 84,163. | E. H. W Blake | November 17, 1868. |
| 85,337. | S. M Skidmore | December 29, 1868. |
| 85,501. | S. A. Wood | December 29, 1868. |

**Ve-lour′.** A hatter's lustering and smoothing pad of silk or plush ; from *vellour*, Fr. Also called *lure.*

**Ve-lours′.** A fabric for upholstering, carpentry, etc. It is a velvet or plush, partly of linen and partly of double cotton warps with mohair yarn weft.

**Vel′vet.** (*Fabric.*) A silk fabric in which the warp is passed over wires so as to make a row of loops which project from the backing, and are thus left by withdrawing the wire for an *uncut* or *pile velvet ;* but are cut by a knife to make a *cut velvet.*

Mentioned in Joinville and in the will of Richard II. Called, anciently, *vellet.*

" There bought velvett for a coat and camelott for a cloak for myself." — Pepys's *Diary*, 1666.

**Vel-vet-een′.** (*Fabric.*) A cut-piled fabric of cotton. It differs from velvet only in respect of the material. Wheu it has a twilled back it is called *Genoa.*

**Vel′vet-loom.** A pile-fabric loom.

**Vel′vet-pa′per.** Wall-paper printed with glue and dusted with shearings of cloth or flock.

It was invented by Lanyer, who obtained an English patent in 1634. He employed shearings of wool, silk, and other materials upon backings of paper, cloth, silk, cotton, and leather. See Wall-paper.

**Vel′vet-pile Car′pet.** A carpet made in the same manner as Brussels carpet, except that the wire, over which the loops of the worsted yarn are made, is of a flattened form, and has a grooved upper surface, which acts as a director for the knife by which the series of loops is cut. The carpet is known as *Wilton carpet.* See Brussels Carpet.

**Vel′vet-tree.** (*Puddling.*) The point where the draft from the neck of the furnace is turned upward into the stack.

**Vend.** (*Mining.*) The whole quantity of coal sent from a colliery.

**Ve-neer′.** 1. (*Wood-working.*) A thin slip of wood or ivory glued or cemented to a piece of other material, and forming an ornamental covering therefor.

The practice of veneering is very generally applied to furniture ; common woods, such as pine, being thus caused to assume the exterior appearance of rosewood or mahogany.

That this art was practiced by the Egyptians, the tombs of Thebes will verify. Wilkinson identifies it as of the date of Thothmes III., whom he considers the Pharaoh of the Exodus, and who was heavily in the brick business. Bricks with his stamp are more numerous in Egypt than those with any one other pronomen.

In the annexed cut, we see a man fitting a piece of red wood to a plank of yellow wood ; at least they are so colored in the original. He has stuck his adze into a block of the same yellow wood, probably sycamore, and in his vicinity are shown his tool-chest and the square. A man is engaged in grinding something on a slab, and another is spreading something on a board, which is thought to be glue, for several reasons : it is kept hot on the fire ; it is shown in connection with joining two slabs of wood ; and a piece of something is represented just by, which has an irregular edge, supposed to represent the concave fracture of a piece of glue. This was their systematic mode of representing any branch of industry : the material, its shaping, and the tools and articles employed.

Fig. 6937.

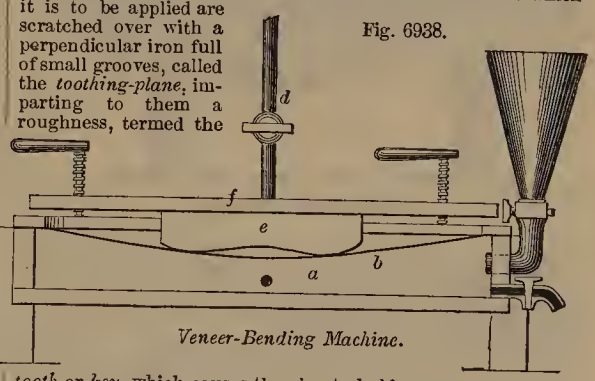
*Veneering in Egypt*, 1490 B. C.

Of the flexible beech veneers used in the construction of boxes and desks, Pliny says that the tuberosities and knots which gave the circular figures and wavy lines to the citrus, terebinth, palm, holly, box, maple, etc., gave them value for covering wood whose grain had not these variegations. Covering common wood with thin veneers of a higher priced wood, and subsequently with laminæ of horn, ivory, and tortoisc-shell, was also practiced in his day. He speaks with disgust of the " monstrous invention of paint and dyes which were applied to the woods and veneers to imitate other woods or give the appearance of the grain of wood to ivory," etc.

Veneers are attached either by the *hammer* or by the *caul.* The former is more readily and generally applicable to small works. The back of the veneer and the surface to which it is to be applied are coated with a thin glue or a stiff size, the surface is then warmed, and the face of the veneer having been coated with glue and warmed, it is applied to the surface, and the hammer (see Veneering-hammer) is drawn across it with a wriggling motion, forcing the liquid glue out at the edges. Where the two pieces to be united are large, several hands are employed in this operation.

*Cauls* are plates or molds, adapted to the shape of the surface, either flat or curved, to which the veneer is to be applied. They are held to the work by clamps operated by screws, and, together with the veneer, are heated previous to being applied. Their operation in effecting a perfect union between the two surfaces is more effectual than that of the hammer. Previous to gluing, both surfaces of the veneer and the surface to which it is to be applied are scratched over with a perpendicular iron full of small grooves, called the *toothing-plane*, imparting to them a roughness, termed the *tooth* or *key*, which causes the glue to hold.

Fig. 6938.




*Veneer-Bending Machine.*

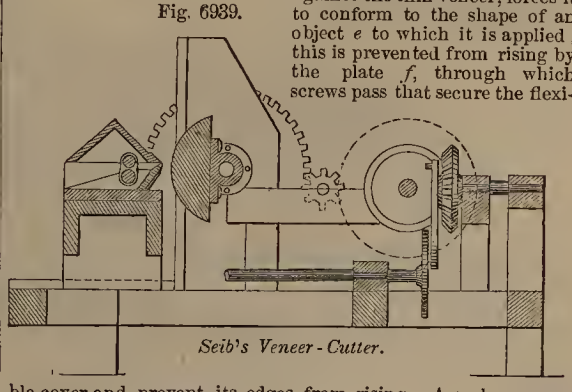
A veneer of ivory, 41 feet long and 14 inches wide, was shown at the London Exhibition, 1851. It was sawn from a rotating block, forming a spiral ribbon, which was then flattened.

This method originated in Russia, and was first applied to wood.

**Ve-neer′-bend′ing.** Fig. 6938 illustrates a machine for applying veneers with an equal and uniform pressure to curved and other surfaces.

It consists of a trough *a*, provided with a top *b* of flexible and water-proof material. The trough is filled with warm water through the funnel and pipe *c*, provided with a stop-cock, and has a pipe *d* through which hydraulic pressure is applied by a force-pump or otherwise, lifting the flexible top, which, acting against the thin vencer, forces it to conform to the shape of an object *e* to which it is applied ; this is prevented from rising by the plate *f*, through which screws pass that secure the flexible cover and prevent its edges from rising. A cock *g* serves to empty the trough.

Fig. 6939.

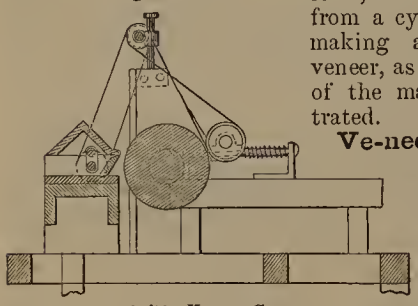


*Seib's Veneer-Cutter.*

**Ve-neer′-cut′ter.** Fig. 6939 is the Seib veneer-

cutter; the veneer is cut from a semicylindrical log. Fig. 6940 is another form, in which it is cut from a cylindrical log, making a continuous veneer, as in some other of the machines illustrated.

Fig. 6940.

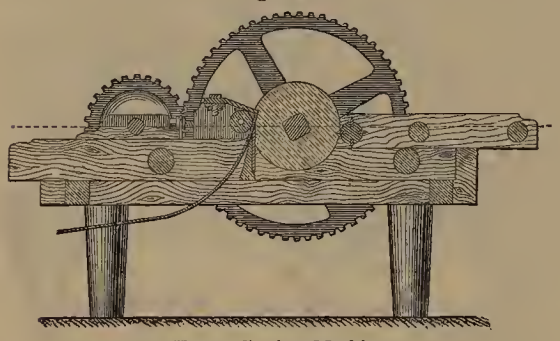


*Seib's Veneer-Cutter.*

**Ve-neer'-cut'ting Ma-chine'.** A machine for *cutting* veneers from the log or block; as distinct from *sawing*.

In Humphrey's machine (Fig. 6941), the cutter, a long thin blade the whole width of the veneer to be cut, is slightly inclined from the perpendicular. The block is first turned to a cylindrical form, and is clamped so as to receive a rotary motion. A presser-roller acts against the wood in advance of the

Fig. 6941.



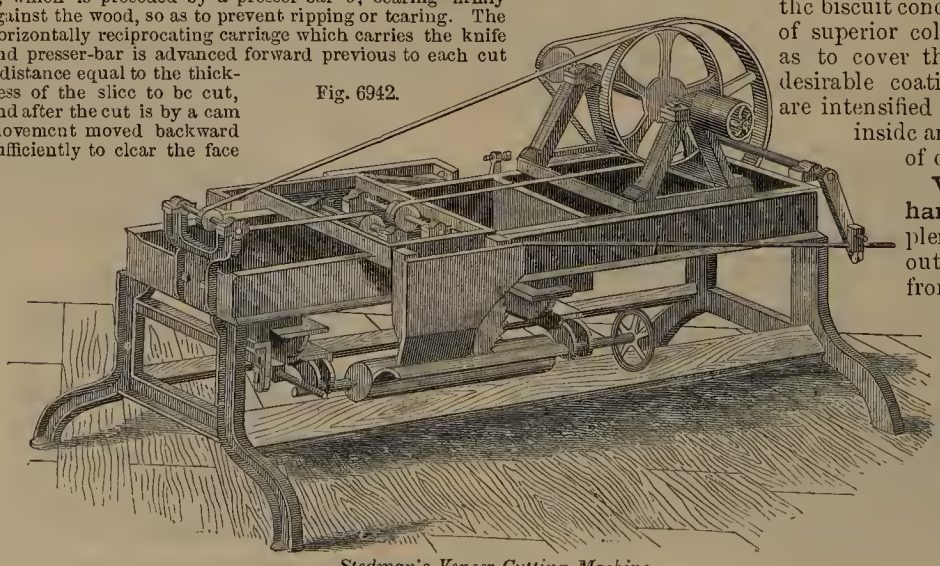
*Veneer-Cutting Machine.*

knife and removes the veneer. The knife is secured to a carriage, which has a progressive forward motion toward the center of the block, and cuts a continuous veneer. The distance between the roller and knife is adjustable to regulate the thickness of the slip.

Stedman's (Fig. 6942) is designed for cutting a continuous strip from a circular block of wood or ivory, which is held between two revolving mandrels on a carriage, which has an intermittent upward feed previous to each successive cut of the circular saw, which is hung from a carriage having a longitudinal forward and return movement. The saw is accompanied by a guide which facilitates the action of the saw and conducts away the severed strip.

In Parker and Sleeper's machine (Fig. 6943), the block *d* is secured by bolts to a vertically reciprocating carriage *e*, and is drawn downward to be presented to the action of the knife *a*, which is preceded by a presser-bar *b*, bearing firmly against the wood, so as to prevent ripping or tearing. The horizontally reciprocating carriage which carries the knife and presser-bar is advanced forward previous to each cut a distance equal to the thickness of the slice to be cut, and after the cut is by a cam movement moved backward sufficiently to clear the face of the ascending block. The severed veneer *c* passes through the throat between the knife and the presser-bar.

Fig. 6942.



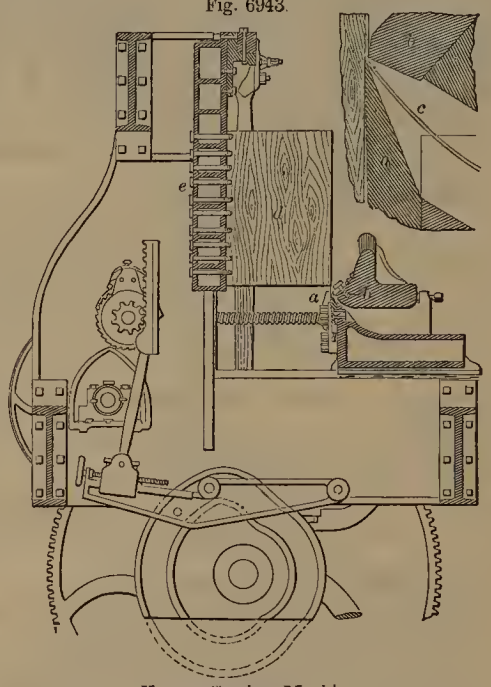
*Stedman's Veneer-Cutting Machine.*

**Ve-neer'ing.** 1. The process of covering the surface of an object with a thin sheet or sheets of more ornamental material, in order to improve its appearance.

For the method of veneering wood on wood, etc., see VENEER.

To veneer marble on zinc: take a plate of zinc about $^1/_{10}$ inch in thickness; make a frame of such a shape as will compose one of the parts of the clock case or other object; over this glue

Fig. 6943.




*Veneer-Cutting Machine.*

sand-paper rough side out. On the sand-paper place hot tar mastic and apply the veneer of marble previously heated.

2. (*Paper-making.*) The process of covering a sheet of one quality or color of paper by a second sheet of differing quality or texture.

It was invented by Dickinson, England, and as applied by him, the sheets of imperfectly compacted paper were laid together and united by pressure.

3. (*Pottery.*) A process termed *veneering* has been adopted with some kinds of pottery where a strong but coarse and unsightly ware is dipped, while in the biscuit condition, into a paste of superior color and quality, so as to cover the biscuit with a desirable coating, whose colors are intensified by a glaze. The inside and outside may be of different colors.

**Ve-neer'ing-ham'mer.** An implement for forcing out superfluous glue from between a veneer and the piece to which it is applied. It is either made of iron, with a very thin and wide peen, or more commonly of a piece of wood three or four inches square, with a round handle pro-

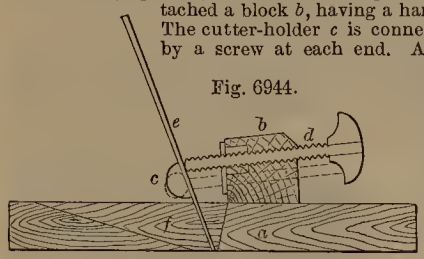
jecting from the center. One edge of the hammer-head is sawn down for the insertion of a piece of sheet iron or steel that projects about ¼ of an inch, having a straight, round, smooth edge, and the opposite side of the head is rounded to prevent it from hurting the hand.

**Ve-neer'-mill.** A saw-mill arranged for cutting veneers. See VENEER-SAW.

**Ve-neer'-plan'ing Ma-chine'.** An implement for smoothing veneered and other surfaces.

Tauner's (Fig. 6944) consists of a sole-plate *a*, to which is attached a block *b*, having a handle at each end. The cutter-holder *c* is connected to the block by a screw at each end. A central thumb-screw *d* serves to adjust the angle of inclination of the cutter *e*. The shavings ascend through the throat *f*.

Fig. 6944.

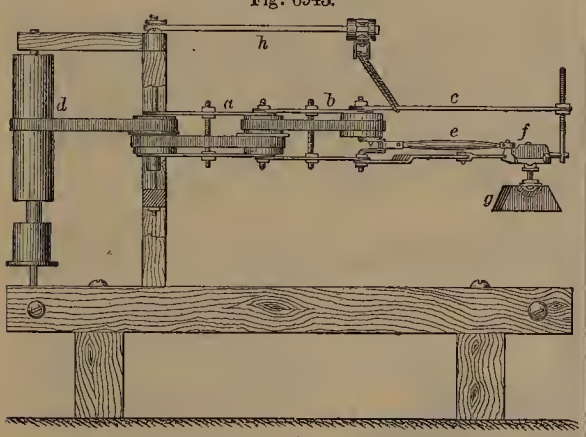



*Veneer-Planing Machine.*

**Ve-neer'-pol'ish-ing Ma-chine'.** A machine for giving a fine bright surface to veneer or vencered work.

Spear's machine has three sets of connected arms *a b c*, carrying three pulleys, the first of which receives motion from the drum *d*, and communicates motion to the second, which, in turn, transmits it to the third; the axis of the latter is cranked,

Fig. 6945.

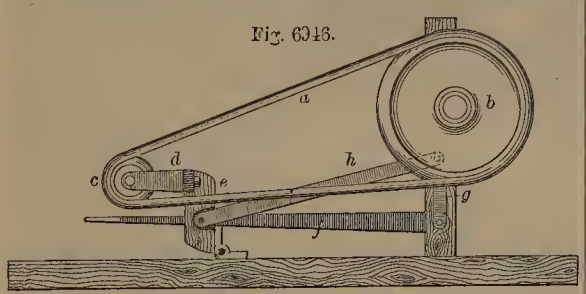



*Veneer-Polishing Machine.*

and through the pitman *e* reciprocates the carriage *f*, from which the rubber *g* depends. The whole arrangement has sufficient flexibility to permit the rubber to be traversed laterally by the hand, while the polishing is effected in right lines by its reciprocating motion. The arm *c*, from which the rubber depends, is supported by a cord or chain from the stationary arm *h* above.

Smith's machine (Fig. 6946) comprises a band *a* having its exterior surface covered with an abradant, and passing around

Fig. 6946.



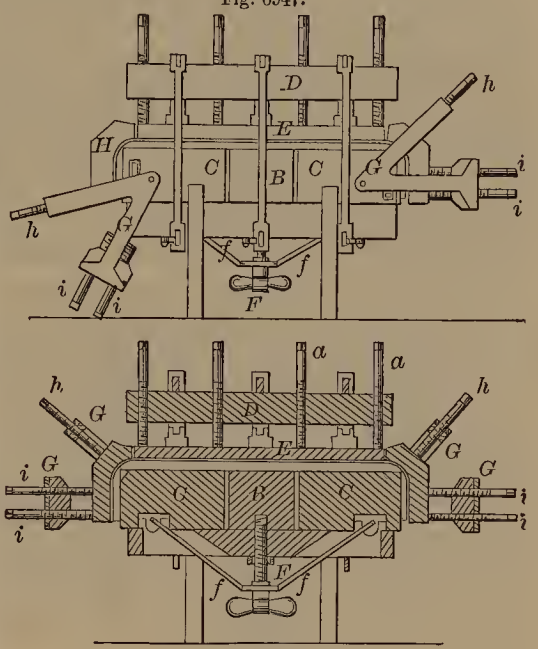

*Veneer-Polishing Machine.*

two half-round faced pulleys *b c*, the latter of which is adjustable toward or from the former, to vary the tension or to remove the belt when it requires re-sanding. It is journaled in the arm *d* connected to the hinged standard *e*, which is moved when desired by the lever *f* through the intervention of the connecting-pieces *g h*. This apparatus is specially adapted for surfaces of irregular curvature.

**Ve-neer'-press.** A press for applying venecrs to the surfaces to which they arc to be attached.

In Fig. 6947, the bed *C B C* is made in three sections, the two outer of which may be separated from or approached to the central one *B* by means of a screw *F* and connecting-rods *f f*.

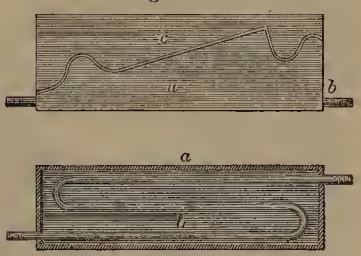
Fig. 6947.




*Veneer-Press.*

The top *D* is hinged at one side and has hinged clamps at the other. Screws *a a* serve to press the plate *E* against the veneer, while the cauls *H H* bend and hold it against the sides of the work. The cauls are operated by screws *h i i* in the pivoted caul-holders *G*, which, when lifted, are held by catches, and are lowered to release the finished work.

Fig. 6948.

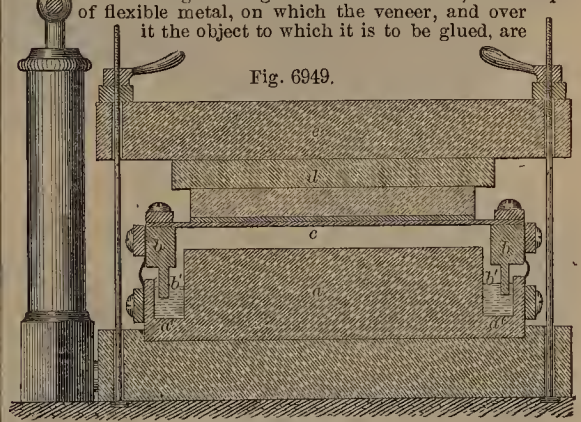



*Veneer-Press.*

In Fig. 6948, the *caul a* is heated by a steam-pipe *b* for the purpose of softening the veneer, to allow it to readily assume the form of a surface *c* to which it is to be applied, and keep the glue in liquid condition until the junction is effected; or the steam may be introduced directly into the caul.

In Fig. 6949, the bed consists of a block *a*, having a groove *a'* running around its margin, and containing water or other liquid; a frame *b*, having a flange *b'* dipping into the water in the groove, and connected with the block *a* by a flexible air and water tight casing of vulcanized rubber; and a top *c* of flexible metal, on which the veneer, and over it the object to which it is to be glued, are

Fig. 6949.




*Veneer-Press.*

laid. Air is forced by a pump into the space between *a* and *b*, raising the frame and its flexible top, and steam is admitted into the cavity at the same time; the veneer is thus applied equally to the surface, and the glue kept fluid. The slab or plank to be veneered is prevented from rising by the block *d*, which is held down by two cross-heads *e*, adjustable as to hight by screws and hand-nuts.

**Ve-neer'-saw.** (*Wood-working.*) A circular saw, made thick at the middle, and tapering to a very thin edge at the periphery; used for separating veneers from the solid block.

Veneer-saws for ivory are sometimes made as small as 6 inches in diameter; more generally 15 to 20 inches. They are run at a lower rate of speed than those for wood, and are made to cut as many as 30 leaves to the inch. Those for wood are frequently of much larger size, are run at a higher velocity, and seldom cut more than 15 leaves to the inch. About one third the material is wasted in sawdust.

The veneer-saw was invented by Isambard M. Brunel, 1805–1808, and it was introduced by him into the Chatham Dockyard, and subsequently into his works at Battersea.

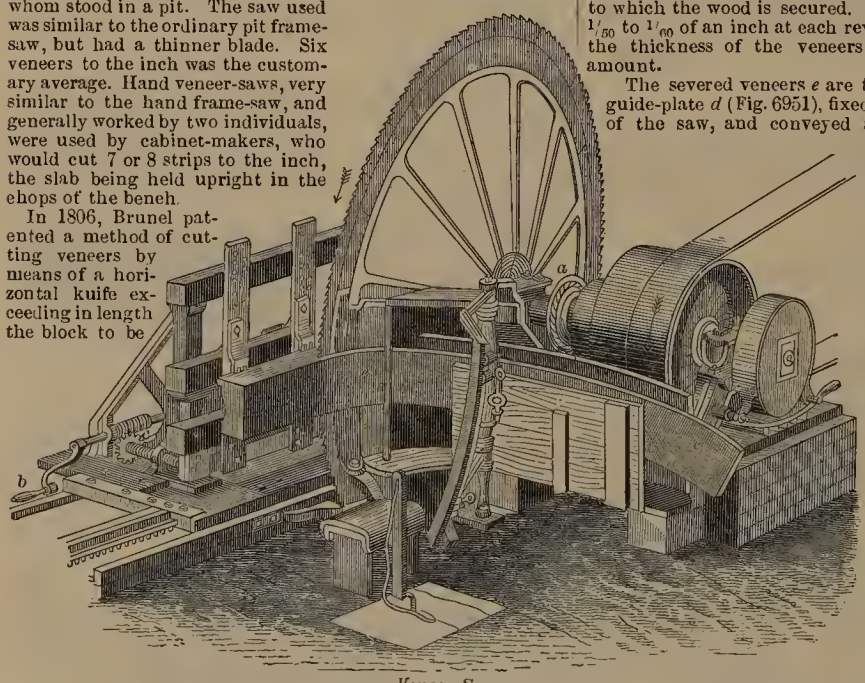
A writer of 50 years since gives the following description of Mr. Bruuel's workshop: —

"In a small building I was attracted by the solemn action of a steam-engine of 16 horse or 80 men power, and was ushered into a room, where it turned, by means of bands, four wheels, fringed with fine saws, two of 18 feet in diameter, and two of 9 feet. These circular saws were used for the purpose of separating veneers, and a more perfect operation was never performed. I beheld planks of mahogany and rosewood sawed into veneers $^1/_{11}$ of an inch thick, with a precision and grandeur of action that was really sublime. The same power at once turned these tremendous saws and drew their work from them. A large sheet of veneer, 9 or 10 feet long and 2 feet broad, was thus separated in about 10 minutes, so even and so uniform that it appeared more like a perfect work of nature than one of human art. The force of those saws may be conceived when it is known that the large ones revolve 65 times in a minute; hence $18 \times 3.14 = 56.5 \times 65$ gives 3,672 feet, or two thirds of a mile in a minute; whereas if a pit-saw worked by two men gives 30 strokes of 3 feet in 1 minute, it is but 90 feet, or only the $^1/_{40}$ part of the steady force of Mr. Brunel's saws." — Sir Richard Phillips's *Morning Walk from London to Kew.*

Previous to Brunel's invention, veneers were cut by sawyers, one of whom stood in a pit. The saw used was similar to the ordinary pit frame-saw, but had a thinner blade. Six veneers to the inch was the customary average. Hand veneer-saws, very similar to the hand frame-saw, and generally worked by two individuals, were used by cabinet-makers, who would cut 7 or 8 strips to the inch, the slab being held upright in the chops of the bench.

In 1806, Brunel patented a method of cutting veneers by means of a horizontal knife exceeding in length the block to be operated on. The knife was composed of several pieces of steel, their lower faces being placed exactly in line, slightly rounded, and having a very keen edge. This had a short reciprocating action, while the block of wood was moved sideways against it by means of a screw slide operated by a hand-wheel. The block was raised to the proper distance after each cut by means of four screws at the angles of the frame, simultaneously operated by a single winch.

Fig. 6950.

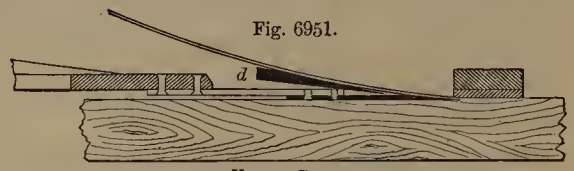



*Veneer-Saw.*

This apparatus converted the whole of the wood into veneers, without waste, and is said to have been tolerably successful with pliant and straight-grained woods, but did not answer well with irregularly grained and brittle woods, as the veneer in this case had a tendency to curl up and split. See Veneer-cutter.

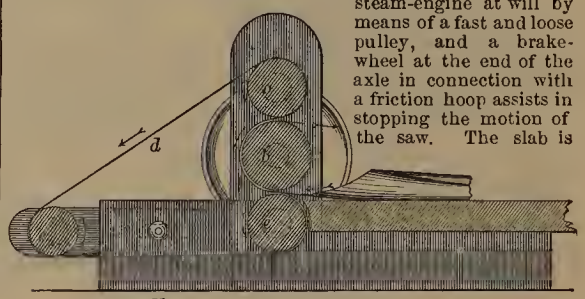
Fig. 6950 illustrates the *segment-saw*, built up of separate plates of steel screwed to the edge of a metallic disk or chuck. In those exceeding 4 feet in diameter, the guidance of the wood is effected by a device called the drag. The veneer generally proceeds from the edge of the saw through a curvilinear trough parallel with its back, but sometimes, as in the present instance, it is conducted away from the saw in front. The axis of the saw is connected to or disconnected from the steam-engine at will by means of a fast and loose pulley, and a brake-wheel at the end of the axle in connection with a friction hoop assists in stopping the motion of the saw. The slab is dogged to the drag, which is carried past the saw by a rack operated by a pinion driven from a band on the pulley *a*, and has devices for producing a quick return motion. A lateral motion is imparted by means of the winch *b*, which turns a rod having a screw-thread at each end, which takes into a corresponding worm-wheel *c* on a screw at each end of the frame to which the wood is secured. The screws advance the frame $^1/_{50}$ to $^1/_{60}$ of an inch at each revolution of the winch, enabling the thickness of the veneers to be graduated within that amount.

Fig. 6951.




*Veneer-Saw.*

Fig. 6952.




*Veneer-Straightening Machine.*

The severed veneers *e* are turned aside by a feather-edged guide-plate *d* (Fig. 6951), fixed nearly in contact with the edge of the saw, and conveyed away by a curvilinear woodeu trough.

**Ve-neer'-straight'en-ing Ma-chine'.** A machine for straightening veneers which have been cut in the form of scrolls from a circular log.

That shown (Fig. 6952) is designed to effect this object by a yielding pressure somewhat gradually applied, so as to obviate the danger of splitting. It consists of three rollers *a b c*, arranged one above the other, or the central one, which is the driver, may be placed somewhat in rear of the other two. A belt *d* of canvas passes around in front of the lower roller, behind the central one, and up and in front of the upper roller, and thence around an adjustable roller *e*, by which its tension is regulated. The veneer is inserted between the lower and central rollers, following the course of the belt, as indicated by the arrows.

**Ve-ne'tian Ball.** An ornamental form of glass for paper-weights, etc. It consists of waste pieces of *filigree glass* conglomerated together in a bulb of clear flint-glass, which is collapsed upon the filigree.

**Ve-ne'tian Blind.** A *louver* shutter or blind made of slats with spaces between them to admit air. In some cases the slats are fixed at a certain angle in the *shutter*; in other cases they are movable to allow the passage of more or less air and light.

The suspended *blind* has cords for support, and others for changing the positions of the slats.

The blind-wiring machine is the invention of Byron Boardman, in 1857. See Figs. 719, 720.

**Ve-ne'tian Car'pet.** A carpet whose warp or chain is of worsted, and generally arranged in stripes of different colors. The shoot, which is generally black, is concealed, and the warp exposed on the two surfaces. The weft is sometimes of different colors, and confers a plaid or check pattern. By the suitable arrangement of the heddles, a twill may be given. The ordinary loom suffices, as no figures are raised.

**Ve-ne'tian Glass.** The *Venetian-glass ball* consists of a number of pieces of filigree glass packed into a pocket of transparent colorless glass, which is adhesively collapsed upon the interior mass by the pressure of the atmosphere as the air is withdrawn by a pump.

The *Venetian filigree* consists of plain and colored enamel laid into a mold and aggregated upon the exterior of a ball of flint-glass. Being enveloped in a film of white glass, the mass is reheated and worked into shape.

**Ve-ne'tians.** A term applied to doors and shutters having luffer openings.

**Ve-ne'tian Win'dow.** One with three separate lights.

**Vent.** 1. (*Ordnance.*) The priming and firing aperture of a gun.

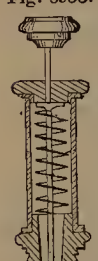
The ventages of ordnance are bushed with copper, a plug of that metal being screwed into the bronze gun and afterward bored for the vent. Copper is less injured by repeated discharges than the bronze (copper, 9: tin, 1), of which the gun is composed. The curved bit of the borer smooths off the end of the plug when making the spherical, parabolical, or other termination to the bore.

The vents of ordnance are $^2/_9$ inches in diameter.

The hardened steel nipple of a gun, accidentally broken in the barrel, may be drilled out by a diamond drill.

2. The opening in the top of a barrel to allow air to pass in as the liquid is drawn out.

Fig. 6953.



*Spring-Vent for Barrels.*

3. (*Foundry.*)

The term employed to comprehend the channels and passages by which the *air*, or gases, escape from the mold. The atmospheric air which fills a mold is rapidly expelled by the hot metal, but this forms only a small part of the gaseous matters driven out in all directions. In damp sand steam is rapidly formed, and some of the water present is also decomposed, giving rise to hydrogen, while its oxygen combines with the carbon contained in the sand to form carbonic oxides. The mold and cores also contain more or less organic matters, such as coal, straw, horse-dung, etc., all of which are decomposed, generating inflammable gases.

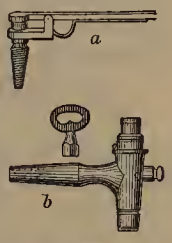
If the mold has *vent* enough, all these gases, known to the molder as *air*, or foul air, will make their way so rapidly to the outside of the mold that a disturbance or boiling of the metal, due to their presence in the mold, and technically called *blowing*, will be impossible. Vent is first secured by the composition of the sand; if it be too fine, or contain too much clay or too much water, or too finely powdered carbonaceous matter, or be rammed too hard, such faults have to be remedied by suitable treatment, which will facilitate its permeation by the gases. The perviousness of the sand after it has been rammed into the mold is also greatly increased by prodding it all over with a long sharp-pointed steel wire (vent-wire) before the flasks are separated or the pattern withdrawn; each channel left by the wire conveys the gases away,—a fact which is made very evident by the small blue flame issuing from all such openings when the mold is filled with metal, and they are fired by a spark. In taking off the air from large castings which are sunk many feet deep in the floor of the molding-shop, large and long passages leading to the surface are necessary. These are connected very carefully with all cavities below from which a rush of gas is possible, and their construction is indeed a matter requiring great judgment and caution, for, mixed with atmospheric air, the inflammable gases from a mold give rise to an explosive compound, which will, if it ignites prematurely, blow the whole to pieces.

**Vent-bit.** An auger for clearing the vent of a gun.

**Vent-cock.** A device for admitting air to a vessel from which liquid is to be drawn, or permit the escape of gas.

The *vent-peg* (*a*, Fig. 6954) consists of a tubular, threaded stem, which may be screwed into a cask, and is provided with an air-tight plunger or stopple, which is lifted by means of a lever.

Fig. 6954.



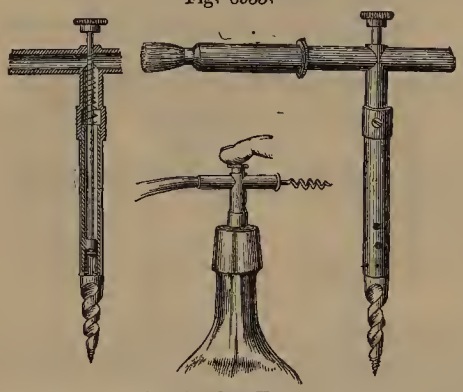

*Vent-Peg and Vent-Cock.*

The *cock b* is adapted to be driven, and is furnished with a key by which its valve is opened and closed.

**Vent-cov'er.** A rectangular piece of leather placed over the vent of a cannon to prevent access of moisture to the box. It is secured to the gun by straps and buckles, and has a copper spike in its center, which enters the vent and prevents its being displaced.

**Vent-fau'cet.** An instrument which may act as a vent-hole borer or a faucet to draw a portion of liquor from the vessel. As shown, it has the accessories of a corkscrew and brush.

Fig. 6955.



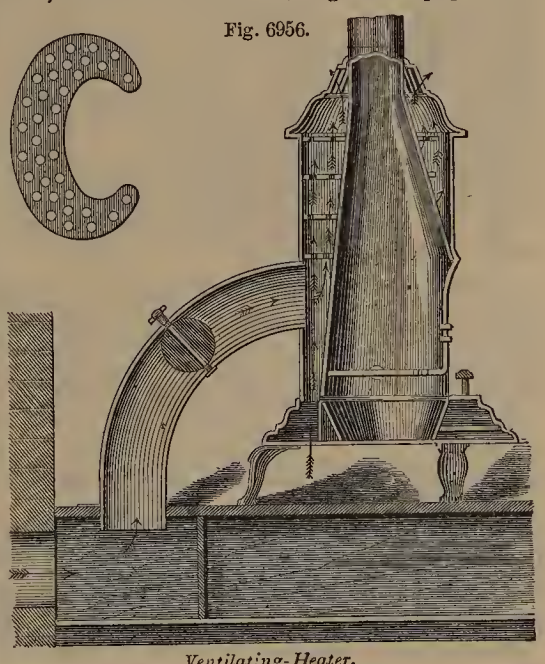
*Love's Vent-Faucet.*

**Vent-field.** A flat tablet around the vent of a gun.

**Ven'ti-lat'ing-bricks** Bricks whose hollows form continuous channels in the walls for purposes of warming, ventilating, and removing moisture from the wall. See BRICK.

**Ven'ti-lat'ing-heat'er.** A form of stove in which the air is drawn fresh from the outside of the building, warmed in the passages of the stove, and discharged into the room. See STOVE, pages 2410, 2411; also HEATING-STOVE, Fig. 2474, page 1090.

Fig. 6956.



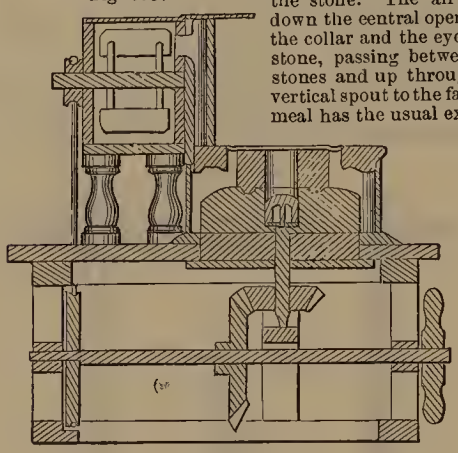
*Ventilating-Heater.*

**Ven'ti-lat'ing Mill-stones.** The system of ventilating mill-stones by vacuum or plenum, by a blast of air in the eye or a suction-fan to the case, seems to have been invented about 1844.

| | | |
|---|---|---|
| See English patents: | Newton, 11,084 | A. D. 1846. |
| | Gordon, 10,163 | " 1844. |
| Belgian patent: | Houyet and Gendebein | " 1844. |
| French patents: | Cabanes | May 29, 1845. |
| | Cabanes | May 26, 1846. |

Fig. 6957 may be taken as an illustration. The collar is connected to the curb by the elastic annular diaphragm, and its lower edge is received in an annular groove in the top of the stone. The air passes down the central opening in the collar and the eye of the stone, passing between the stones and up through the vertical spout to the fan. The meal has the usual exit.

Fig. 6957.

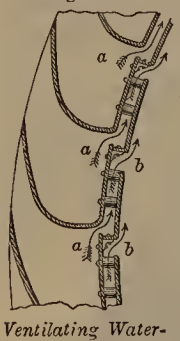


*Ventilated Mill-Stone.*

**Ven'ti-lat'ing-stack.** (*Mining.*) A high stack with a partition and air-furnaces, and connected with the ventilating-flue.

**Ven'ti-lat'ing Wa'ter-wheel.** The water-wheel bucket has an escape for the air toward the interior of the wheel, so as to allow the bucket to fill without confining the air, and to escape freely on reaching the position of discharge.

Fig. 6958.




*Ventilating Water-Wheel.*

It appears to have been first introduced in Scotland, and to have been suggested by the violent eruption of water incident to the confining of the air in the bucket, in some cases forcing a spray to the hight of 6 or 8 feet. The arrows mark the course of the escaping air, from *a* to *b*.

**Ven'ti-la'tor.** An arrangement for supplying fresh and removing vitiated air from buildings, mines, or other places. This may be effected either by withdrawing the foul air and permitting the fresh air to flow in and supply its place (the *vacuum* process); or by forcing in fresh air (the *plenum* process), which drives the foul air before it to the exit. A combination of both processes is also used in certain cases.

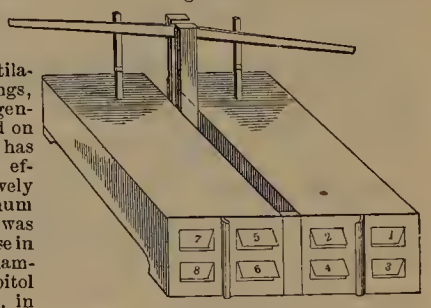
In 1723, Dr. Desaguliers introduced a plan for ventilating the House of Commons by means of fires in upper apartments, which drew the air upward through openings at each angle of the House, whence it was conducted to the chimneys. This plan was not permitted to have a fair trial, and was succeeded by the centrifugal fan, invented by Desaguliers in 1734. One of these was erected over the ceiling of the House, and continued to do duty until 1817, being subsequently superseded by the arrangement contrived by the Marquis de Chabannes.

See "A Course of Experimental Philosophy," by J. F. Desaguliers, LL. D., F. R. S., Chaplain to his Grace the Duke of Chandos. London, 1734.

About 1741, or shortly after the invention of the fan-blower by Desaguliers, the Rev. Dr. Hales contrived a ventilator which he endeavored to introduce into the British navy. It worked on the bellows principle, and was composed of two oblong boxes, each of which had a valve moved up and down by rods attached to a lever working on a central pin. Air was drawn into the machine through inwardly opening valves, and expelled by valves opening outwardly. It required the labor of two men, and the inventor claimed that it was capable of discharging 6 tons of air per minute; but it appears to have met with but little success.

About the same period, Sutton proposed to ventilate ships by pipes leading from the well and other parts of the vessel to the galley fire, which was to receive its sole supply of air through these tubes.

Fig. 6959.




*Hales's Ventilator.*

1. The ventilation of buildings, though more generally conducted on the exhaust, has sometimes been effected exclusively on the plenum principle, as was formerly the case in the Senate Chamber of the Capitol at Washington, in which a combination of both methods is now adopted. General Morin, Director of the Imperial Conservatory of Arts and Trades under the late French Empire, an authority in matters of this kind, gives a decided preference to the vacuum method, for the reasons that the vitiated air is more certainly withdrawn than it can be when expelled by forcing, and on account of the machinery necessarily employed, requiring skilled labor to attend it, which is indispensable in the latter method; while the former, requiring only the same number and arrangement of air-ducts, may be effected simply by the aid of heat.

General Morin indorses the following table, by some considered excessive, of the proper hourly supply of air required for each person in various situations: —

| | CUBIC FEET. |
|---|---|
| Schools, each child, per hour | 400 to 500. |
| Schools, each adult, per hour | 800 to 1,000. |
| Meeting halls, for each person, per hour | 1,000 to 2,000. |
| Theaters, for each person, per hour | 1,400 to 1,700. |
| Prisons, for each person, per hour | 1,700 |
| Workshops, ordinary trades, for each person, per hour | 2,000 |
| Workshops, unhealthy trades, for each person, per hour | 3,500 |
| Ordinary hospitals | 2,000 to 2,400. |
| Hospitals for epidemic cases | 5,000 |

The temperature in general should not exceed, for

| | |
|---|---|
| Workshops | 59° Fah. |
| Hospitals | 61° to 64° Fah. |
| Schools | 66° to 68° Fah. |
| Meeting-rooms | 66° to 72° Fah. |
| Theaters | 68° to 73° Fah. |

The air may be maintained at a higher temperature in well-ventilated apartments than in those where it is not frequently renewed.

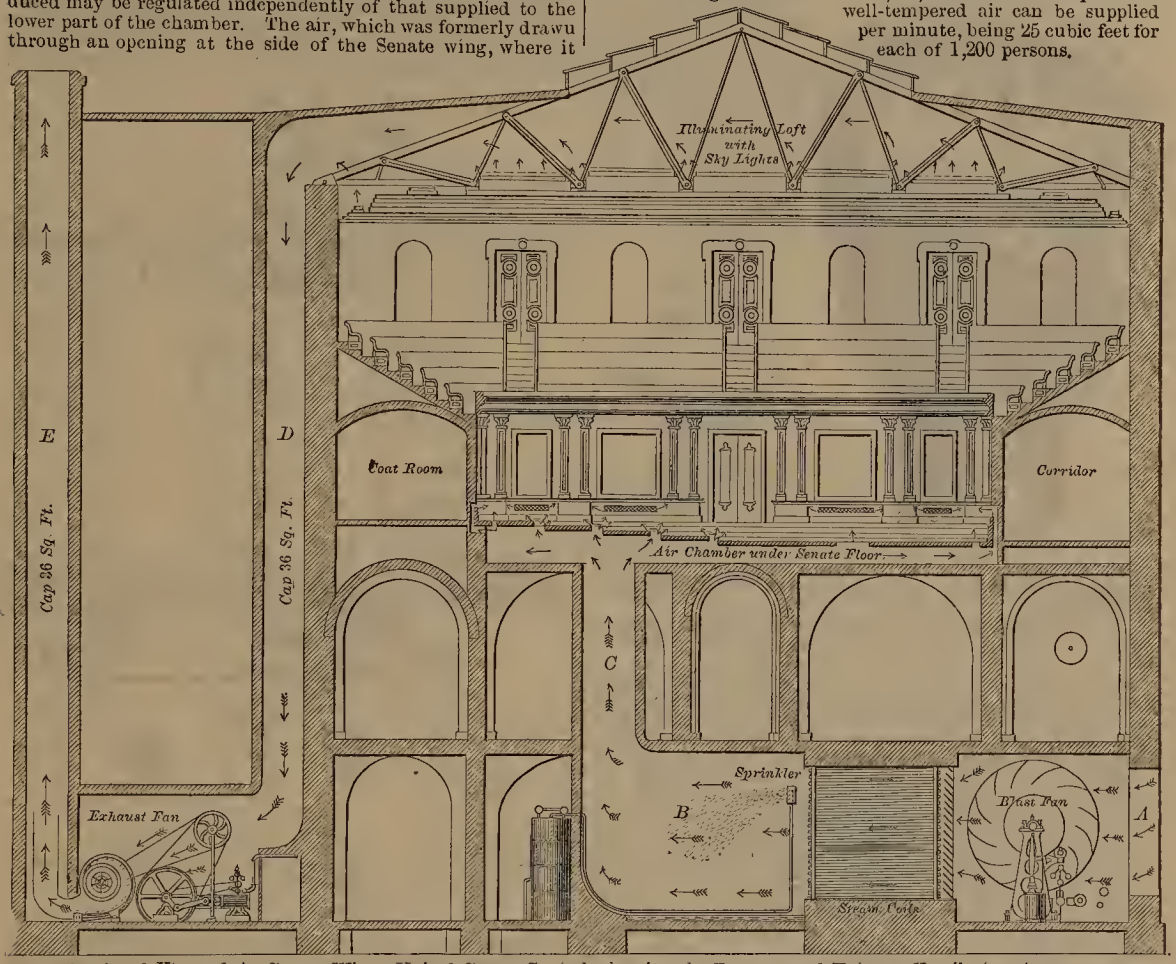
Ordinarily, the fires by which the building is heated are wholly or principally relied on to effect the required renewal of the air. Dr. Arnott's plan, 1838, consists in cutting an opening in the chimney above the grate or fireplace, and providing this opening with a valve which opens inwardly to the flue, so as to draw off the foul air from the upper part of the apartment while preventing the entrance of smoke.

The plan of the Marquis de Chabannes, employed at the Covent Garden Theater, 1819, consisted in using the large central chandelier as the principal ventilating-agent. This was surmounted by an inverted wrought-iron funnel which conducted the hot air into a wooden shaft surmounted by a cowl. Air-passages leading from various parts of the house conducted the foul air into this shaft. A furnace in one of the galleries, and another over the stage, were employed as auxiliaries.

Previous to November, 1870, the Senate Chamber in the Capitol at Washington was ventilated upon the plenum principle exclusively, no exhaust being employed. The fan used for forcing is 14 feet in diameter, moved by an engine of 16 horse-power, delivers 500 cubic feet of air per revolution, and is capable of being run at a speed of 80 revolutions per minute, which is the maximum required for summer ventilation. The upper doorways and the openings in the ceiling were relied on to discharge the vitiated air. The fresh air was introduced through openings at the lower part of the chamber. Owing to defects and contractions in the main induction channel and the distribution passages, however, the requisite quantity of air could not be supplied without causing a strong current on the floor. The speed of the fan had accordingly to be reduced so as to give only about ¼ the quantity of air required. To remedy this defect, two large exhaust-fans driven by a 25 horse-power engine were erected; these draw the air through perforations in the ceiling into the illuminating loft above, thence downward through two descending shafts having a sectional area of 36 square feet into the exhaust-chamber, whence it is discharged through a single upcast shaft having a sectional area equal to

that of the other two combined. A second air-shaft was constructed, leading from the chamber in which the air is either heated or cooled, according to the season, to an air space under the seats of the galleries, into which it is distributed through numerous perforations. The temperature of the air thus introduced may be regulated independently of that supplied to the lower part of the chamber. The air, which was formerly drawn through an opening at the side of the Senate wing, where it was liable to be contaminated by smoke and gas from the neighboring flues, now passes through a tunnel 220 feet long, the mouth of which is located in a position free from these contaminating influences. By these means, 30,000 cubic feet of pure and well-tempered air can be supplied per minute, being 25 cubic feet for each of 1,200 persons.

Fig. 6960.

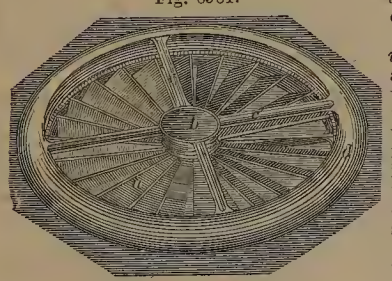



*Sectional View of the Senate Wing, United States Capitol, showing the Pressure and Exhaust Ventilating Apparatus.*

Fig. 6960 is a transverse section of the Senate wing, United States Capitol, illustrating the mode of warming and ventilating the Senate Chamber.

Fresh air is drawn in through an opening *A* in the basement wall by means of two powerful steam-driven blast-fans, which force it through a series of steam-coils into a chamber *B*, where it is charged with aqueous vapor by a sprinkler. It thence ascends through an upcast *C* into an air-chamber beneath the Senate floor, and is admitted into the apartment through registers in the floor and at the sides. Rising to the upper part of the hall, it passes through apertures between the skylights into the illuminating loft, whence it is drawn downward through a descending shaft *D*, having a sectional area of 36 square feet, by steam-driven exhaust-fans, and finally discharged into the open air through an ascending shaft *E* of equal capacity.

Fig. 6961.

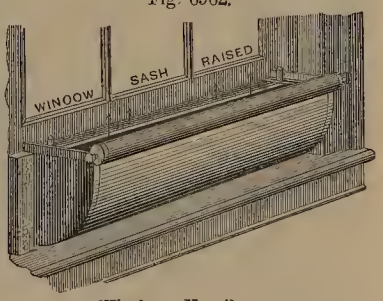


*Ventilator.*

The *ventilator for windows* consists of a wheel with spiral vanes, which is rotated by the outward passage of air from the room. It is usually set in a pane of glass, or occupies the site of a pane

Fig. 6961 is a rotary ventilator for apartments. The wheel *a*, which has a number of radial vanes, is stamped out of sheet-metal, and is journaled in bearings upon disks *b b'* attached to the arms *c c'* of the case *d*. A hole of sufficient size is cut in a window-pane, the case inserted and held by the flanges *e e'* and tongues *f f'*, which are turned up for the purpose.

Fig. 6962.



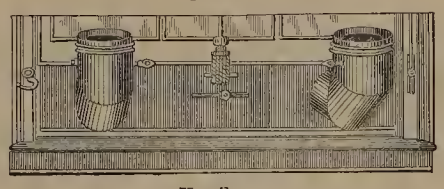

*Window-Ventilator.*

Or a curved chute placed at the opening formed by a raised sash to direct the air upward into a room.

Or a louver arrangement in a pane of glass, or occupying the place of one.

The ventilator, Fig. 6963, consists of a frame which is held between the lower bar of the sash and the sill of the window-frame, and has two elbowed pipes, whose inner ends are vertical, so as to direct the cool air from out doors upwardly into the apartment. The pipes are provided with valves for regulating the quantity of air admitted, or shutting it off altogether.

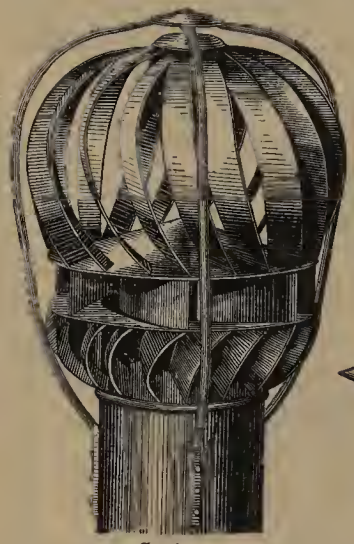
Fig. 6963.



*Ventilator.*

The *chimney-ventilator*, or cowl, assumes many forms. The vanes or plates are inclined, so that the hood is rotated by the action of the wind or of the heated air passing outward.

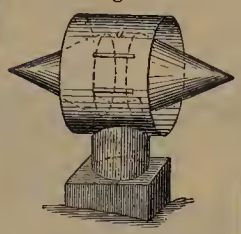
Fig. 6964.



*Cowl.*

In the chimney-ventilator, Fig. 6965, two cones, base to base, are secured to the top of the chimney-pipe and are surrounded by a ring *a*, the object being to create a partial vacuum in the space between the cones and the ring and promote an ascending draft, whichever may be the direction of the wind. See also CHIMNEY; COWL; MULGÛFPUNKAH; etc.

Fig. 6965.



*Double-Cone Ventilator.*

The *barn*, *brewery*, or *stable ventilator* is a louver, story, or cupola, whose lapping but separated slats admit the passage of air.

In the *ventilation of mines*, a series of shafts, termed *winzes*, are sunk from one level to another, permitting the ascent of the more highly heated air from below, causing an ascending current; and the descent of the cooler air from outside, which traverses the various galleries, is usually found sufficient. In coal or other mines where large quantities of dangerous gases are generated, this method is inadequate, and artificial means are resorted to to produce a more powerful ascending current, and cause a more rapid circulation of air. The most simple means of doing this, and that generally employed in coal-mines, is by means of two shafts, in one of which a fire is kept up, rarefying the air and producing a strong draft, which causes the withdrawal of the air from the set of galleries with which this, the upcast shaft, is connected. The downcast shaft communicates with another set of galleries, between which and the first a communication is established at or near the extreme end of the mine, so that the air which descends through it to replace that which is being carried off by the upcast shaft flows through the whole extent of the mine before arriving at the latter. Where a fire is inadequate to produce sufficient ventilation, other exhaust apparatus, generally the fan, is resorted to. In some cases but a single shaft is used, which is divided by a vertical partition, termed a *brattice*, one portion serving for the *upcast*, and the other for the *downcast*. The air-pump is also employed for ventilating mines as well as buildings; one of these, near Liege, is described as consisting of two wooden cylinders 11 feet 7 inches in diameter, open at top, and having valved bottoms. The pistons which were attached to the opposite ends of a beam were fitted with upwardly opening valves, were reciprocated by connection with the piston-rod of a 13-inch steam-cylinder fixed over one end of the beam, had a stroke of 6 feet 2 inches, and with a boiler pressure of 41 pounds per square inch discharged 17,000 cubic feet of air per minute.

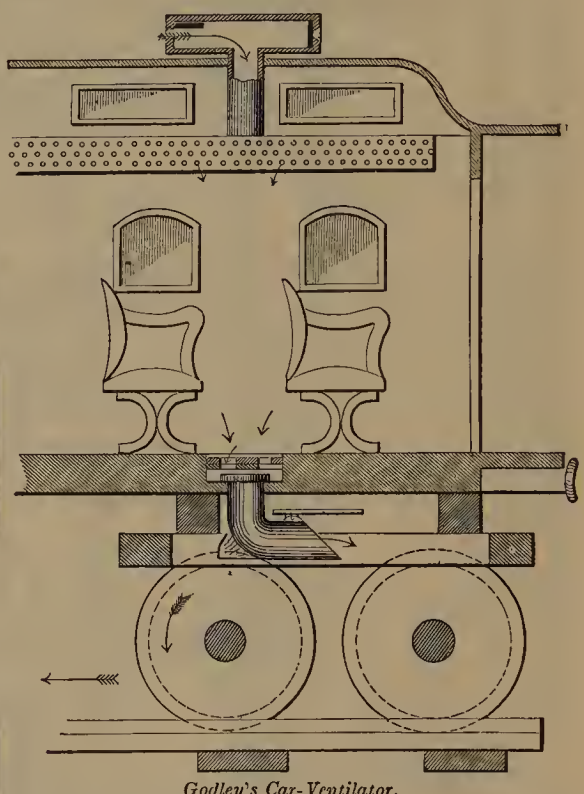
The form of air-pump in which a vacuum is produced by the alternate partial submersion of a cylinder or cylinders into water, and partial withdrawal therefrom; the "plunging bells" of the Hartz, the "duck-machine" of Cornwall, and the air-holder of Belgium are of this class, and have long been employed in mines. More modern varieties are the double-acting airometer of De Vaux and Struve's mine-ventilator. These each consist essentially of two air-holders, similar to gas-holders, which alternately dip into water and produce the exhaust. The air-holders are, of course, of large size; one of a pair of Struve's producing an exhaust of 60,000 cubic feet of air per minute, being 20 feet in diameter, stroke not stated.

In the Belgian mines centrifugal ventilators of very large size, from 18 to 27 feet diameter, have come into general use. The principal kinds noticed are Rittinger's, Gallez's, Lambert's, and Guibal's, the two former having curved and the two latter straight wings; their minor details also differ. The most effective of these are stated to utilize from 30 to 40 per cent of the total power of the engine.

In some of the deep mines in France the miners work in air maintained at a density of three atmospheres. This pressure is obtained by means of pumps driven by a steam-engine, and is apparently very beneficial to the men. When about to descend, they enter a closed anteroom, into which air from the shaft is admitted to establish an equilibrium. The manhole is then uncovered for their descent.

Various patents have been granted for devices for *ventilating railway-cars*. These generally embrace the following essential features: 1, a mouth adjustable toward the direction in which the train is proceeding, and having an inclined top which deflects downward the current produced by the motion of the train; 2, an arrangement to catch the dust and sparks; and, 3,

Fig. 6966.



*Godley's Car-Ventilator.*

a downwardly descending pipe to direct the purified air into the car. The principle is essentially that of the wind-sail employed on shipboard.

In Clement's patent, November 22, 1853, sponge or other porous material, kept constantly moist by water from a suitably arranged chamber, is used as an air-filter.

Godley's car-ventilator acts by *vacuum* process. It has swiveled elbow-pipes, placed underneath the floor of the car, connecting with the interior of the latter by means of registers, and so arranged that the exit-openings are toward the rear of the train, the suction of the atmosphere having the effect of drawing the air out of the car through the elbow-pipes.

See also Figs. 95 to 99, page 46.

The *ventilator for ships* is commonly a wind-sail; a large tube of canvas having an expanded mouth, which is turned in the direction of the wind while the tube is directed down the hatchway, conveying the air to the lower deck. The contrivances of Hale and Sutton have been mentioned. Dr. Thiers, of New York, has patented (November 29, 1870) an apparatus in which the oscillating motion of mercury contained in a horizontal tube or tubes running athwartships and fore and aft, producing a partial vacuum, is caused to exhaust the foul air. The fluid is kept in motion by the rolling and pitching movements of the vessel.

Perkins, about 1820, proposed to ventilate ships by using two barrels half filled with water, placed diagonally to the line of the keel, and connected by a pipe. Pipes with inwardly opening valves led from the hold to each cask, and other pipes with outwardly opening valves led from the casks to discharge-ports. The rolling and pitching of the vessel caused an alternate flow from one cask to the other, by which the foul air was alternately drawn into and expelled from each cask.

The *ventilator for hats* consists of a hole in the crown, and a head-band supported at a certain distance from the sweat-lining, so as to allow upward passage of air around the head.

The *ventilator for boots* consists of a double upper with holes; the motion of the foot being relied upon for causing circulation of air.

The *ventilator for stacks*, *mows*, and *granaries* consists of a perforated air-duct which allows the heated air and moisture to pass off.

**Ven-tose'.** A cupping-glass.

**Vent-piece.** (*Ordnance.*) *a.* A plug of copper containing the vent, and screwed into its position in the gun.

*b.* The block which closes the rear of the bore in a breech-loader.

**Vent-pipe.** An air or steam-escape pipe.

**Vent-plug.** A stopper for the vent of a gun.

**Vent-punch.** It is made of steel, slightly less in diameter than the vent, and is used for clearing the vent when it has become foul or scaly.

**Vent-stop'per.** A plug or cap to close the vent-hole.

**Vent-wire.** (*Founding.*) A long steel wire, one end of which terminates in a bow and the other in a sharp point. It is used, as described above, for giving vent to green and dry sand-molds.

**Ve-ran'da.** An open portico attached to a house.

**Verge.** The spindle or arbor of a watch-balance. The term is commonly applied to that of the old vertical movement, whose *balance-arbor* has two *pallets*, which alternately engage with teeth on the opposite sides of a *crown-wheel*, whose axis is at right angles to that of the *verge*. See VERTICAL ESCAPEMENT.

**Verge-es-cape'ment.** See VERTICAL ESCAPEMENT.

**Verge-file.** A fine file with one *safe* side, formerly used in working on the verge of the old vertical escapement.

**Ver'meil.** 1. Silver gilt; gilt bronze.

2. (*Gilding.*) A liquid applied to a gilded surface to give luster and fire to the gold, making it resemble ormolu. It is composed of

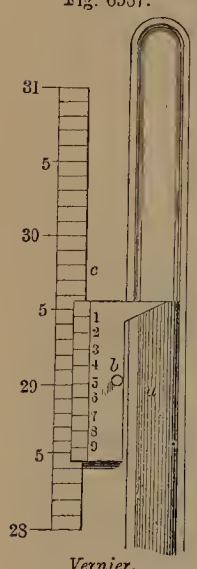
| | |
|---|---|
| Annotto | 2 ounces. |
| Gamboge | 1 ounce. |
| Vermilion | 1 ounce. |
| Dragon's blood | ½ ounce. |
| Salt of Tartar | 2 ounces. |
| Saffron | 18 grains. |
| Boiled in..Water | 2 pints. |

Steam, and apply with a soft brush.

**Ver-mil'ion.** A brilliant red color originally derived from cinnabar, — a native sulphide of mercury, — but generally prepared artificially. It is made in large quantities in Europe and elsewhere, the processes varying somewhat in different places. The Chinese is the most esteemed and most expensive.

**Ver'ni-er.** A divided sliding scale used for measuring any portions of the space between two of the smallest divisions of a graduated instrument. It derives its name from Peter Vernier, a gentleman of Franche-Compté, who described it in a tract printed at Brussels in 1631. Also called *nonius*, from Peter Nunnez or Nonius, a Portuguese mathematician, born 1497, to whom its invention has been ascribed.

Fig. 6967.




*Vernier.*

The vernier is attached to astronomical and surveying instruments, to the barometer, and to the beam-compass and other scales for rectilinear measurements.

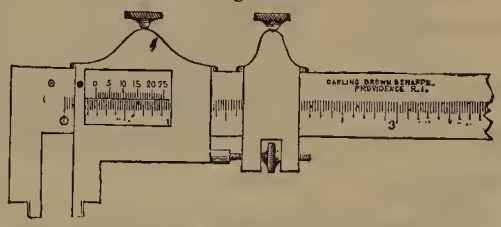
That applied to the barometer, Fig. 6967, will illustrate its principle, *a* representing the mercurial column, *b* the vernier, and *c* the barometer-scale, divided into inches and tenths. The vernier-scale is $11/10$ inches in length, and is divided into 10 equal parts, each embracing $11/100$ of an inch, and therefore exceeding each division of the scale by $1/100$ of an inch. If therefore any division of the vernier coincide with a division on the scale, that division, counting downward, when the 0 of the vernier coincides with the top of the mercurial column, indicates the number of hundredths of an inch to be added to the tenths division on the scale next above which the 0 of the vernier stands.

In the mountain-barometer and scales for nice measurements, the vernier is constructed to read to thousandths of an inch by the aid of a microscope.

In circular instruments, graduated to degrees and half-degrees, a space on the vernier equal to 30 divisions of the limb is divided into 29 parts, thus allowing measurements to be made to minutes.

By further subdividing and the use of the microscope, readings down to 10″, 5″, or even single seconds are effected, as in the case of high-class astronomical instruments.

Fig. 6968.



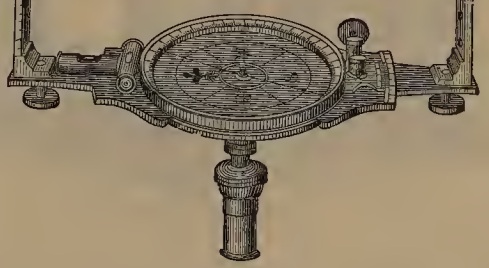

*Brown, Shape, and Co.'s Vernier-Caliper.*

**Ver'ni-er-cal'i-per.** A caliper with vernier-graduations.

One side of the vernier-caliper reads to thousandths of inches; on the other side are 64ths of inches, to read without a vernier. Instead of 64ths of inches, some are divided with verniers, reading to 20ths of millimetres, French measure. This instrument is furnished with both inside and outside calipers, and points to transfer the distance with dividers. These instruments are made of steel, and have the points tempered and the jaws ground.

**Ver'ni-er-com'pass.** A surveyor's compass whose compass-circle with a vernier attachment is movable about a common center by turning a tangent-screw at the south end of the instrument. It is adapted to retrace the lines of old surveys where the variation of the compass has changed, and to surveys of public lands where the lines are based on a true meridian.

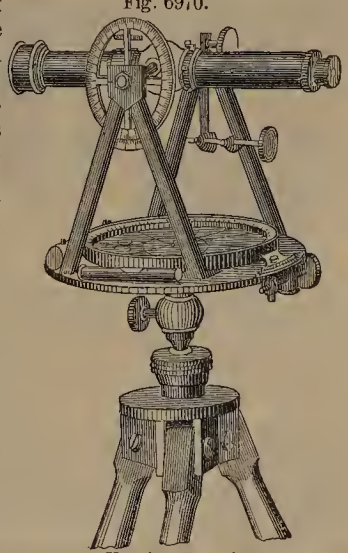
Fig. 6969.



*Vernier-Compass.*

**Ver'ni-er-tran'sit.** A surveyor's transit having a vernier-attachment to the compass, by which the latter may be adjusted to indicate the *true* instead of the magnetic bearings.

Fig. 6970.



*Vernier-Transit.*

**Ve-ro'na-serge.** A thin worsted and cotton fabric.

A fabric of mohair and cotton variously colored.

**Versed Sine.** In mechanics, the rise of an arch.

**Ver'ti-cal Bor'ing-ma-chine'.** A drill or boring-machine having a vertical spindle. See Figs. 814, 815, 816.

**Ver'ti-cal Buhr-mill.** One in which the buhrs rotate in a vertical plane. See Fig. 2316, page 1021.

**Ver'ti-cal Dial.** A dial having a plane fixed to a wall, tower, or house. The angle formed by the gnomon is the complement of the latitude, the style preserving its parallelism with the earth's axis. See DIAL.

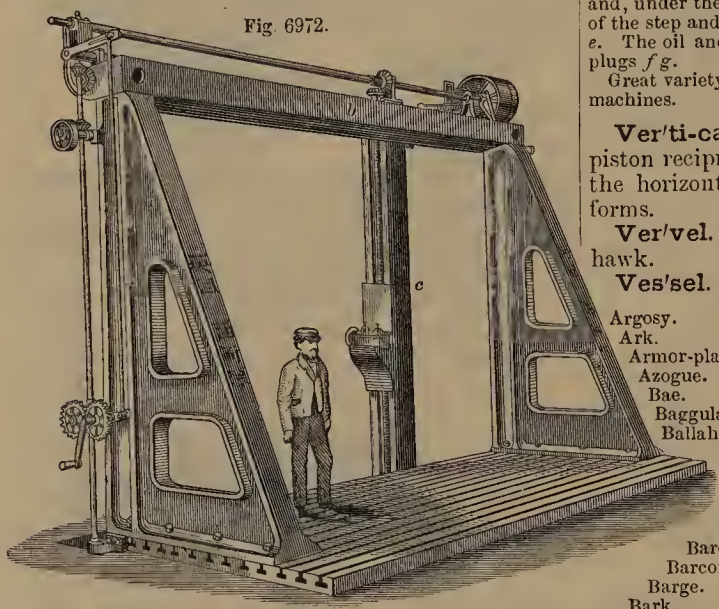
Fig. 6971.

*Vertical Escapement.*

**Ver'ti-cal Drill.** One with a vertical spindle. See Fig. 1770, page 751.

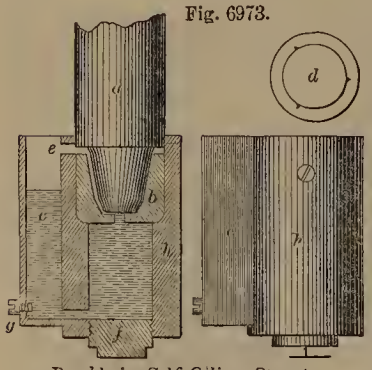
**Ver'ti-cal Es-cape'-ment.** The *vertical* or *verge escapement* is old-fashioned, and has been superseded by more lasting contrivances which admit of a flatter movement.

Fig. 6972.



*Vertical Planing-Machine.*

Fig. 6973.



*Dunklee's Self-Oiling Step for Vertical Spindles.*

Its inventor is not known. The teeth of the *scape-wheel* are detained by the *pallets* on the *verge*, the upper and lower ones acting alternately. The *scape-wheel* is a *crown-wheel*, and its axis is at right angles to that of the verge. This makes its plane of revolution *vertical*, the plane of oscillation of the balance being assumed to be horizontal. The construction necessitates a certain thickness of watch, which is so familiar in old time-keepers. To reduce the thickness, the planes of revolution were brought into parallelism, which brings us to the next device, called by its then distinguishing characteristic, — the *horizontal*.

**Ver'ti-cal Mill.** See GRINDING-MILL, Fig. 2316.

**Ver'ti-cal Plan.** The ground-plan, or *orthography*.

**Ver'ti-cal Plan'ing-ma-chine'.** A planing-machine in which the cutting action of the tool is performed in a vertical plane. The cut illustrates a machine of this class, built by Messrs. John Bourne and Company for the Chinese government.

The base-plate is of cast-iron, grooved longitudinally to receive T-bolts for securing the work. Two standards *a* support the longitudinal beam *b*, which carries the shafting and bevel-gear by which the cutter-head screw is rotated. The screw and tool-holder are carried by the upright bar *c*, which has a longitudinal motion in guides at the top and base of the machine, and is advanced the proper distance after each cut by screws above and below. The cutter-holder is caused to move twice as fast upward as it does downward, and three tools may be employed if desired. The example can cut 16 feet horizontally and 12 vertically.

**Ver'ti-cal Pump.** One in which the plunger or bucket moves vertically, — the more common form.

**Ver'ti-cal Spin'dle-step.**

Fig. 6973 shows Dunklee's self-oiling step. *a* is the spindle; *b*, the step resting in the socket *h*, which has a chamber beneath, communicating with the oil-chamber *c*, which is filled with the lubricant to a higher level than the foot of the spindle. The lubricant ascends through an aperture in the bottom of the step and through vertical grooves on its interior, shown at *d*, and, under the influence of centrifugal force, flows over the top of the step and back into the oil-chamber through the aperture *e*. The oil and sediment may be removed by unscrewing the plugs *f g*.

Great variety is shown in the steps for spindles of spinning-machines.

**Ver'ti-cal Steam-en'gine.** One in which the piston reciprocates vertically, as distinguished from the horizontal, inclined, or rotary, — all common forms.

**Ver'vel.** A silver name-ring around the leg of a hawk.

**Ves'sel.** See under the following heads: —

Argosy.
Ark.
Armor-plated vessel.
Azogue.
Bae.
Baggula.
Ballahore.
Ballast-lighter.
Ballon.
Balsa.
Banker.
Barangay.
Barca.
Barcon.
Barge.
Bark.
Barquantine.
Barque.
Batardates.
Bateau.
Becasse.
Bilalo.
Bilander.
Bireme.
Bir-lin.
Boat.
Bomb-ketch.
Brig.
Brigantine.
Broad-horn.
Bucentaur.
Budgero.
Buggalow.
Buggy-boat.
Bumboat.
Bunder-boat.
Bungo.
Buss.
Cable.
Caique.
Canal-boat.
Canoe.
Caper.
Carack.
Caracore.
Caravel.
Carvel built.
Catamaran.
Chain-boat.
Chebec.
Chop-boat.
Cigar-steamer.
Clipper.
Coaster.
Cock.
Collier
Coracle.
Corvette.
Cowan.
Crane.
Cray.
Cutter.
Dandy.
Dhoney.
Dhow.
Dingy.
Dispatch-boat.
Dogger.
Doney.
Dory.
Dow (dhow).
Dredge-boat.
Drogher.
Dug-out.
Dummy.
Dwang.
Farcost.
Felucca.
Ferry-boat.
Fire-ship.
Flat-boat.
Floating-battery.
Floating-light.
Fly-boat.
Fourth-rate.
Frigate.
Frigatoon.
Fuuny.
Galeas.
Galiot.
Galleon.
Galley.
Gallivat.
Garkookah.
Gaydiang.
Gig.
Gondola.
Grab.
Gunboat.
Hawker.
Hermaphrodite brig.
Hooker.
Horse-boat.
House-boat.
Howker.
Hoy.
Hulk.
Ice-boat.
Iron-clad.
Iron-vessel.
Jigger.
Jolly-boat.
Junk.
Kajak.

Keel-boat.
Ketch.
Koff.
Launch.
Life boat.
Lighter.
Light-ship.
Liner.
Long-boat.
Lorchà.
Lugger.
Man-of-war.
Marine car.
Massoulah boat.
Monger.
Monitor.
Monkey-boat.
Mortar-vessel.
Mud-boat.
Mulette.
Oil-carrying vessel.
Outrigger.
Packet.
Paddle-box boat.
Periaugua.
Pink.
Pinnace.
Pirogue.
Polacca.
Ponton.
Portable boat.
Praam.
Prahu.
Privateer.
Proa.
Pungy.
Punt.
Raft.
Raising sunken vessels.
Ram.
Razee.
Remberge.
Scamparia.
Schooner.
Scow.
Sectional boat.
Settee.
Shallop.
Sheer-hulk.
Shield-ship.
Ship.
Skiff.
Skute.
Sloop.
Smack.
Snag-boat.
Snow.
Steamboat.
Steam-ram.
Steam-vessel.
Stone-vessel.
Submarine battery.
Submarine boat.
Tank-vessel.
Tartan.
Team-boat.
Tender.
Topsail-schooner.
Torpedo-boat.
Tow-boat.
Track-boat.
Trow.
Tug.
Turret-ship.
Twin-boat.
Two-topsail schooner.
Vakka.
Whale-boat.
Wherry.
Xebec.
Yacht.
Yawl.

**Ves'sets.** A kind of cloth.

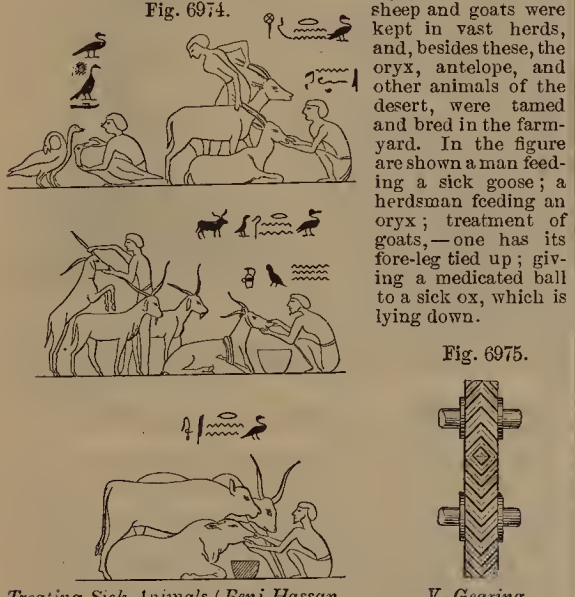
**Ves'ta.** A kind of wax-match.

**Ves'ti-bule.** An ante-hall, lobby, or porch.

**Vet'er-i-na-ry In'stru-ment.** See SURGICAL INSTRUMENTS.

Fig. 6974 shows the practice of the veterinary art in ancient Egypt. Oxen and sheep and goats were kept in vast herds, and, besides these, the oryx, antelope, and other animals of the desert, were tamed and bred in the farm-yard. In the figure are shown a man feeding a sick goose; a herdsman feeding an oryx; treatment of goats,—one has its fore-leg tied up; giving a medicated ball to a sick ox, which is lying down.

Fig. 6974.



*Treating Sick Animals (Beni Hassan, Egypt).*

Fig. 6975.



*V-Gearing.*

**V-gear Wheel.** A duplex arrangement of skew-gearing in which each tooth is of the shape of the letter V.

**Vi'a-duct.** An elevated road for the passage of vehicles. Bridges are viaducts; but the latter term is especially applied to arched or truss structures which cross valleys or gorges where the width of water-course is but a fraction of the distance traversed. Viaducts are constructed where the depth renders embankments infeasible.

One of the longest viaducts is that of the London and Greenwich Railway, which is 3 miles 60 chains long, laid on more than 1,000 arches of yellow brick, 18 feet span, 22 feet high, 25 feet wide. Opened in 1838. Cost, $1,300,000 per mile. Extinguishing title to property swallowed a large portion, and extinguished some of the owners at the same time.

The London and Blackwall Railway is built in the same manner upon a continuous series of brick arches. Its length is 3 miles 38 chains, and its cost £1,083,951.

Remarkable viaducts are shown in the railway-bridges (so to call them) over the Susquehanna and many Southern rivers; the Ohio, at Louisville. In England: over the Avon, on the line of the London and Northwestern Railway; the Victoria Bridge, over the valley of the Wear; the Crumlin Viaduct, in Wales. In France: over the Monie, near Nantes. In Holland: over rivers and *dieps*. In India: over the Ganges.

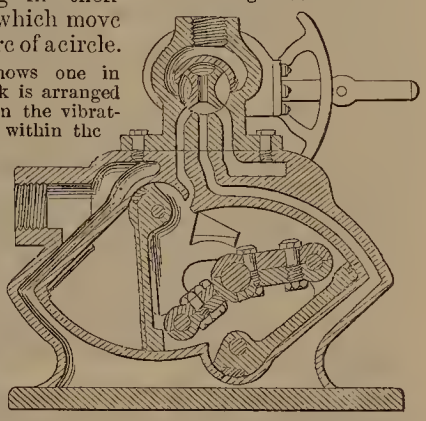
See BRIDGE; TRESTLE; TRUSS; WOODEN BRIDGE; etc.

**Vi'al.** A small, long bottle.

**Vi-a-tom'e-ter.** A way-measurer, as its name indicates. See ODOMETER; PEDOMETER.

**Vi'brat-ing-pis'ton Steam-en'gine.** One in which the power is communicated to the crank through pistons which are vibrating in their motion, and which move through an arc of a circle.

Fig. 6976.

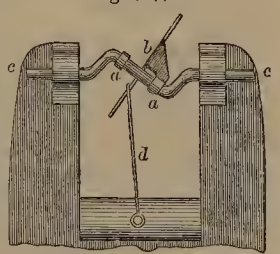


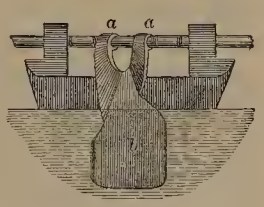
*Vibrating-Piston Engine.*

Fig. 6976 shows one in which the crank is arranged directly between the vibrating-piston and within the cylinder, the connections between the pistons and the cranks being so arranged that each piston, though being only single-acting, may act upon the crank during more than half of each revolution of the latter, thereby avoiding the occurrence of any dead point in the revolution of the engine. The connection of the side-packing strips of the piston with the end strips is accomplished by means of pins and slots, in combination with the mortise and tenon joints in the same.

**Vi'brat-ing-pro-pel'ler.** A propeller which operates by a sculling movement.

Fig. 6977.




*Vibrating-Propeller.*

In that illustrated, the two arms *a a* of the blade *b* are sleeved upon an inclined crank on the shaft *c*, having its bearings in two sternward projections from the hull of the vessel. A link *d* is loosely jointed to the blade *b* and to the vessel, to maintain the blade in a fore-and-aft position, while a laterally reciprocating motion, reversed at each revolution, is imparted by the rotation of the propeller.

**Vi'brat-ing-roll'er.** (*Printing.*) A roller having a reciprocating end motion, to equalize the ink on the sub-plate or surface.

**Vi'brat-ing Steam-en'gine.** A steam-engine which vibrates on a center. See OSCILLATING STEAM-ENGINE.

**Vi'bro-scope.** 1. An instrument invented by Duhamel for counting the vibrations of a tuning-fork.

The tuning-fork is fixed in a horizontal position, and has a light style, attached to one of its prongs by wax. To receive the trace, a piece of smoked paper is gummed around a cylinder, which can be turned by a handle, a screw cut on the axis causing it at the same time to travel endwise. The style barely touches the blackened surface. The fork is made to vibrate, and the cylinder turned, the style making a mark whose waves

correspond to the number of vibrations, and the number of these by count in a second of time is the number of vibrations of the fork. By plunging the paper in ether, the trace may be fixed and the number counted at leisure.

2. An instrument invented by Mr. Wesselhoft of Riga, designed to enable an observer to make direct observation of the motion of a vibrating object.

It is founded on the principle of the phenakistoscope or the zootrope, and consists of a rapidly rotating disk having equidistant sight-holes. The vibratiug object is viewed through these by means of a telescope, and, owing to the persistency of vision, appears constantly in view, though its change of position, as it is seen successively through each aperture of the revolviug disk, is distinctly perceptible, aud its vibrations, which are in reality rapid, will appear comparatively slow, enabling the observer to readily trace its path.

**Vic-to'ri-a.** A park-carriage having a low seat for two persons, a calash top, and an elevated driver's seat in front.

**Vign-ette'.** The term was formerly applied to ornaments consisting of tendrils and *vines* upon silver, and hence the name. Rastoldt, in 1471, is credited with the introduction of this mode of portraying initials, flowers, etc. Pynson was the first English printer to introduce borders and vignettes in his books.

**Vign-et'ter.** (*Fine Arts.*) The photographer's instrument for giving a vignette appearance to a portrait or print, the edges fading away insensibly into the background.

**Vi'na.** A fretted instrument of the guitar kind, used by the Hindus; it usually has seven strings or wires, and a large gourd at each end of the finger-board. Its extent is two octaves.

It is of great antiquity. It has movable frets fastened by wax, so as to be regulated to suit the scale of the picce to be played. The usual musical scale has 22 intervals, called *scruti*, in the compass of an octave.

**Vi'ne-fi-ca'teur.** A French apparatus for collecting the alcoholic vapors that escape from liquids during the process of vinous fermentation. It is a conical vessel or cap, covering a hole in the top of the fermenting-tun, which is in other respects closed air-tight. The conical vessel is surrounded by a reservoir of cold water, so that the spirituous vapors, rising from the liquid, will be condensed on the side of the reservoir, and, running down its sides, be returned to the tun. A tube carries off uncondensed vapors.

**Vin'e-gar.** Ordinary vinegar may be defined as a dilute acetic acid, mixed with other acidifying and flavoring ingredients, varying with the material employed in its production. Wine-vinegar contains, besides the acetic acid, tartaric acid and a minute proportion of acetie ether. Alcohol-vinegar also has a small proportion of acetic ether. Cider-vinegar, besides acetic, contains malic acid. Malt-vinegar, which is the kind principally used in England, contains, in addition to acetic acid, most of the constituents of beer.

The vinegar of Sphettus was celebrated by Aristophanes and Athenæus as remarkably pungeut.

Vinegar may be derived from any saccharine solution capable of undergoing alcoholic fermentation, the alcohol being converted into acetic acid by the subtraction of two atoms of hydrogen and the addition of two atoms of oxygen.

Wine-vinegar is made — principally in France, Orleans being a chief seat of the manufacture — from inferior wines and grape refuse. The liquid is clarified by straining through a tun filled with beechwood chips, and is then placed in casks, which are filled about two thirds full, and kept in a room where a constant temperature of 86° is maintained. The process occupies several weeks. The process of making cider-vinegar is entirely analogous, all that is required being that the liquid should have sufficient time and heat to pass to the alcoholic, and from that to the acetous fermentation.

Malt-vinegar is prepared by making a wort, as in brewing; a ferment is added, and the wash or *gyle*, as it is then called, being placed in casks, is acetified either by *stoving* or by *fielding*. By the first method this is effected in close rooms heated by stoves or steam pipes to a temperature of 70° to 80°, or upward.

In the second method the casks are exposed to the open air, arranged in parallel rows with walks between, the whole arrangement being termed a *field*. The bung-holes are left open in fine weather, but covered by a tile during rains. When completely acetified, — a process which usually requires several months, — the vinegar is drawn off by a siphon, and is afterward clarified by being passed several times through the *rape*, a large vat containing a compact heap of the skins and stalks of raisins.

The quick method, invented originally by Boerhaave, consists in causing the liquid to be acetified to percolate through a vessel, in which it is finely divided, so as to expose a large surface to the air. By this the time required is very much reduced. Various methods and apparatus have been employed for this purpose.

**Vin'e-gar-ap'pa-ra'tus.** A tub in which cider, malt-wort, or other fermented wash is allowed to trickle through shavings, exposed to the action of the air. An *acetifier*. See GRADUATOR.

Fig. 6978.

*Vine-Rake.*

**Vine-rake.** An implement for pulling sweet-potato or other vines off from the ridges preparatory to the digging of the ground.

The beam carries a fork or rake made with two forwardly curved teeth. The rake is drawn by a pair of animals, one walking on each side of the ridge, and as the team advances the teeth pass under the vines and tear them loose from the ground, carrying them along until the rake becomes full.

**Vi'ol.** 1. (*Nautical.*) A large messenger used in weighing an anchor by the capstan. *Voyol.*

2. (*Music.*) A typical instrument of the violin class. See VIOLIN.

Fig. 6979.

*Viol.*

Fig. 6979 shows an ancient form of instrument, known at a later period as the *monochord*, from its single string. It was played with a plectrum. The whole series of stringed instruments may be reasonably assumed to have grown from the lyre, for which, to follow the myth or the history, whichever it may be, the dried tendons in the shell of a tortoise gave the first suggestion. The corn-stalk fiddle of the Southern negro is, to some of us, a familiar illustration of a rustic instrument with but slight capability for expression, but at the same time suggestive of better things. (See LYRE.) See also, for various antique forms of lyre, Plate LII. +, Bonanni's "Instrumens Harmouiques," Rome, 1776.

**Vi'ol-block.** (*Nautical.*) A large *snatch-block*. See SNATCH-BLOCK.

**Vi'o-la.** (*Music.*) The second instrument of the viol class, having four strings, tuned a fifth below those of the violin; the C and G strings are covered with silver wire. Its ordinary compass is 3 octaves. It is written on the G clef, 3d line, and on the G clef when it extends high.

**Vi-ole' d'A-mour'.** (*Music.*) A bow instrument of the viol class, rather larger than the *viola*. It has 7 catgut strings, the three lowest of which, like the C and G strings of the viola, are covered with silver wire. Below the neck of the instrument, and passing beneath the bridge, are seven metallic strings tuned in unison with the others, so as to vibrate sympathetically with them. Its compass is $3\frac{1}{2}$ octaves, and is written on two clefs.

**Vi'o-lin'.** (*Music.*) A stringed instrument played by a bow, the highest in its range of its class. It has 4 strings tuned by fifths, and all capable of be-

ing shortened by the left hand. Its compass is 3½ octaves, written on the G clef.

Of its class are the

| | |
|---|---|
| Violin. | Viola d'amour. |
| Viol. | Violone. |
| Viol de gamba. | Violoncello. |
| Viola. | Contra-basso. |

The four strings of the violin are supported at their respective ends by the *pins* in the *head* and by the *tail-piece*. The neck has no frets, unlike the guitar.

Fig. 6980.

*Violin.*

The *violoncello*, *viola*, the obsolete *viol*, the violone (contra-basso or double-bass), are allied to the violin, are or were played with the bow, and differ in the number of strings (the viol had a fretted neck and six strings) and in the compass of the instruments.

The viola was a fifth lower in compass than the violin. The violoncello, or bass-viol, is an octave below the violin; and the violone, or double bass-viol, is an octave below the violoncello.

As the tones of strings depend upon the number of vibrations in equal times, the strings in the instruments of lower compass are larger. In a piano tuned to an ordinary pitch for the parlor, the middle A of the treble clef will be produced by 420 vibrations per second.

The range audible to an ordinary ear as a distiuct musical tone is about from the 4th deseending C below this A to the 4th ascending C above it, and the vibrations are stated as follows, putting the said A in its place in the series: —

| | |
|---|---|
| $C^4$ | 4,032 vibrations per second. |
| $C^3$ | 2,016 vibrations per second. |
| $C^2$ | 1,008 vibrations per second. |
| $C^1$ | 504 vibrations per second. |
| A | 420 vibrations per second. |
| C | 252 vibrations per second. |
| $C_1$ | 126 vibrations per second. |
| $C_2$ | 63 vibrations per second. |
| $C_3$ | 31½ vibrations per second. |

See Siren.

It has been proposed to apply keys to the finger-board of the violin, by pressing which the strings may be shortened by a definite amount, so as to produce the proper note without depending upon the skill or judgment of the former in applying his fingers directly to the strings.

The chirping and singing of the cricket and grasshopper are frequently spoken of; but they do not sing, — they *fiddle*. By rubbing wings and legs together — each in the manner peculiar to the species — these insects produce the sounds which characterize them.

Stringed instruments with a finger-board, and played with a bow, are found among the Chinese, Japanese, Hindus, Persians, and Arabs, besides the European nations, and their descendants in other countries.

The original of the piano-forte is the *harp*, which, laid prostrate, becomes the *dulcimer*, known to the Arabs and Persians as *santir*, and to European nations of some centuries since as the *cimbal*, the *cymbaly* of the Poles, and the *cimbalom* of the Magyars of the present day. The instrument assumed many forms; beaten like the modern *dulcimer*, shown in Fig. *i*, Plate XL., from a work published in 1536; or twanged by the fingers or plectra, as in Fig. *j*, same plate, a *citole* from a drawing in the British Museum. The *citole*, or finger-played dulcimer, was the *psalterium* of the fourteenth century; Italian, *salterio;* English, *psaltery*.

The addition of the key, *clavis*, made the *cembalo* or *cithara*, a *clavicembalo* or *clavicetherium* respectively, *l* and *k*, of Plate XL.

The Hindus claim to have invented the violin-bow, their *ravanastron* or ancient violin being cited in ancient Sanscrit writings.

In the "Edda" we read of the intestines of a cat being made into a cord for Lok, the evil one of the Scandinavian myths. The lyre-strings, said to have been invented by Lynus as a substitute for thongs of leather or twisted strings of flax, were made of sheep's intestines, οιων χορδας of Homer. *Catgut* is the *nerviclus* of the Middle Ages.

A representation of the Anglo-Saxon *fithele* is given in a MS. of the eleventh century in the British Museum. (Cotton, Tiberius, c. 6.) The instrument is pear-shaped, had four strings, and has no apparent bridge. A German fiddle of the ninth century is also shown, copied by Gerbert from the MS. of St. Blasius; it has only one string. German fiddles of the twelfth and thirteenth centuries are also shown.

The "Nibelungenlied" Volker is described as wielding the fiddle-bow as dexterously as the sword.

Paintings of a fiddle on the interior of the roof of Peterborough (England) Cathedral date from the twelfth century. One has the incurved sides and S-shaped sound-holes.

The upper group in Fig. 6981 is from a MS. of the fourteenth century (MS. Reg. 2, B. vii., British Museum), of the angelic host at the creation. The original represents angels playing upon the fiddle, cittern, shalm, harp, and trumpet. The portion represented in our cut has but the first two instruments.

Fig. 6981.

The lower group is also from a MS. of the same century (Brit. Mus. MS. Addit. No. 10,293), where a performer on the fiddle is accompanied by others on the dulcimer and bagpipe.

Pepys, in his Diary (1661), states that he "took a great deal of pleasure [at the coronation of Charles II.] to go up and down, and look upon the ladies, and to hear the musique of all sorts, but, above all, the 24 violins." His devotion to music and to the ladies was remarkable, and occasionally got him into trouble.

*Violin.*

He elsewhere refers to his own practice on the "viallin," and to an abominable "base viall" at Hempson's, which, with his fiddle, made the "worst music I ever heard."

"He [Templer] is a great traveller, and says all the harvest long the fiddlers go up and down the harvest fields [in Italy?] everywhere, in expectation of being hired by those that are stung [by the tarantulas]." — Pepys, 1662.

"We into the house and there fell to dancing, having extraordinary musick, two viollins, and a base viollin and theorbo, four hands, the Duke of Buckingham's musick, the best in towne. . . . . I paid the fiddlers £3 among the four, and so to bed." — Pepys's *Diary*, 1668.

A mention of the fiddle in England occurs in the legendary tale of St. Christopher, written early in the thirteenth century: —

"The king loved the melody of fithele and of song."

Fig. 6982.

The instrument was noticed by Chaucer, but was not common till the time of Charles II., who, in imitation of Louis XIV. and his band of performers under the leadership of Beltazarini, established a band of twenty-four fiddlers; hence the old refrain, —

"Four-and-twenty fiddlers all of a row."

The *rebec* was an instrument having successively 2, 3, and 4 strings, and was played by a bow. It was introduced by the Saracens or Moors into Europe, and was known in Italy in the twelfth century. It and its name are derived from Arabia.

*Syrian Kermanjek, and 'ood.*

The modern Arabian fiddle, the *kermanjek*, is supported on the ground like our violoncello, and has two or three strings. The neck is like that used among us, having no *frets*. In Thompson's illustration, which we copy, the body is made like that of their *derbekkeh*, or drum. A calabash, or bowl, with a parchment cover, upon which the bridge-piece is supported. In the mode of covering, it resembles our banjo, but, unlike the banjo, the body of the *kermanjek* is closed at the rear.

Away in Chinese Tartary the Abbé Huc records, "A boy took down a sort of violin with 3 strings, that hung on a goat's horn, and presented it to the head of the family." He was glad to escape from the tent during a lull in the "bawling" of "the terrible virtuoso," "taking advantage of a moment when he stopped to swallow a bowl of tea."

The art of violin-making, naturalized in Italy in the fifteenth century, appears to have reached its culminating point in the productions of the Cremonese school, about the close of the seventeenth. Antonio Stradivarius, who flourished at this period, stands, by common consent, at the head of all violin-makers. The instruments of Guarnerius are scarcely less renowned, both commanding almost fabulous prices, while those of other makers of the same school and period enjoy a reputation far above that of more modern instruments. This is no doubt due in part to age, which imparts a mellowness of tone to stringed instruments, but is believed also to be largely attributable to the correct adjustment of their proportions and skill in arranging their minor details, as well perhaps as to a choice of the materials from which they were made. To determine the fact as far as possible, and with a view of throwing historical light on the development of Italian violin-making, the directors of the Austrian Exposition of 1873 in Vienna invited the exhibition of instruments of this class, dating from the earliest periods down to the close of the eighteenth century.

See Sandy and Forster's "History of the Violin." See also

an article in "Lippincott's Magazine," September, 1874, pp. 352–360.

**Vi'o-lin'-pi-a'no.** (*Music.*) A form of the piano-forte patented some thirty years since in England by Todd. It is intended to give the violin tone to the piano-strings by the pressure upon the string of an endless band covered with powdered resin like the bow of a fiddle.

This is effected by the pressure of the foot of the player upon a pedal, which puts the endless band in motion, and the band is caused to rub against the particular wire, as the key appertaining thereto is depressed by the finger of the player.

This violin attachment was in addition to the usual hammer action; and was brought in as an auxiliary at pleasure.

An instrument on this principle, termed the tetrachordion, was exhibited at the Paris Exposition of 1867 by its inventor, M. Baudet. In this each string consists of a single wire, and is surrounded by a tuft of fiber, the upwardly projecting ends of which are, by the action of the keys, brought in contact with the rosined surface of a roller covered with parchment or leather, and revolved by the alternate action of two treadles.

**Vi'o-lon-cel'lo.** (*Music.*) A bow instrument of the viol class, having 4 strings tuned in fifths an octave below the *viola*. Its compass is 3½ octaves.

**Vi'o-lo'ne.** (*Music.*) A large bass-viol, one octave lower than the *violoncello*, and 2 octaves below the violin. A *double-bass*.

**Vir'gi-nal.** (*Music.*) An instrument consisting of a number of strings stretched in a frame like that of a harp, and played by means of *hammers* and *keys*. It was one of the precursors of the piano-forte, and was well known to the musical profession and the cultivated classes of society in the sixteenth and seventeenth centuries; how much earlier we do not know. See *n*, Plate XL.

A book of exercises for the virginal, written for Queen Elizabeth, is still extant.

The *pit-a-pat* motion of the fingers, so different to the clawing action of the hands in playing upon the harp, gave occasion to Shakespeare to compare to it the love-taps of his heroine, —

"Still *virginating*
Upon his palm."

This man, whom nothing escaped, made words as he wanted them.

A century later Gabriel Platte describes a dibbling-machine as formed of iron pins

"Made to play up and down like *virginal jacks*."

After many essays and various changes in movement and application, after the *virginals*, *manichords*, *clavichords*, *harpsichords*, and *spinets* had had their day, the piano came forth, "beyond all question the first of musical instruments." — THALBERG.

The "virginall" and printed "virginall-book" are several times mentioned by Pepys, 1660–63.

"Took Aldgate Street on my way, and there called upon one Hayward that makes Virginalls, and there did like of a little espinettes [spinet] and will have him finish them for me; for I had a mind to a small harpsichon, but this takes up less room." — PEPYS'S *Diary*, 1668.

It is commonly said that "the idea of making the hammer of the harpsichord *strike* the string instead of *pulling* it gave rise to the piano-forte." The substitution of the *hammer* for the *plectrum* was, however, made in the *virginal* a century before the introduction of the *harpsichord*. The *clavichord* was also a well-known instrument, and operated by keys and wires, which acted as hammers. The *virginal* had a padded hammer, consisting of a leather button on the top of the hammer-wire. With the exception that the harpsichord had two strings and the virginal but one, it is easier to see the original of the piano-forte in the *virginal* than in the *harpsichord*, in construction as well as date.

These instruments, with hammers and quills in various forms and combinations, having been in use for nearly three centuries at the time the piano-forte was introduced, it is hardly worth while to give credit to any particular person at that late date for the invention of an instrument in which the *strings of a prostrate harp were struck by hammers*. The improvements on that well-known device were, however, great, and the piano may be said to date from that of B. Christofori of Florence, 1711. See *A*, Fig. 3386, and accompanying description, page 1691.

**Vis-à-vis.** A dress-carriage for town use.

**Vise.** 1. An instrument with two jaws, between which an object may be clamped securely, leaving both hands free for work. The hand-vise is not a vise proper, but has a tang which is grasped by one hand, while the other holds the tool to work upon the object held.

A better definition could hardly be given than that of the "Autocrat of the Breakfast-Table," when vice-president at a feast where the presiding officer was too voluble and gave him not half a chance: —

"A vise is something with a screw that 's made to hold its jaw
Till some old file has played away upon an ancient saw."
O. W. HOLMES.

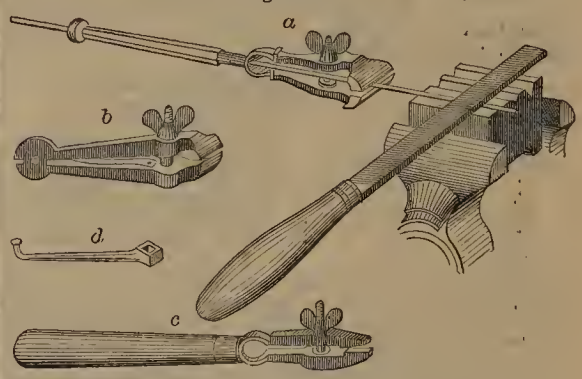
It is said to have been invented by a disciple of Pythagoras, one Archytas of Tarentum, about 516 B. C. Pliny must always find an inventor for an object.

Vises are known by purpose or construction: —

| | |
|---|---|
| Barrel-vise. | Hand-vise. |
| Bench-vise. | Pipe-vise. |
| Calking-vise. | Saw-vise. |
| Foot-vise. | Screw-vise. |
| Glaziers' vise. | |

In Fig. 6983, *a* is a *pin-vise*, used by watch-makers in filing small pins and other cylindrical objects. The jaws are not united by a joint, but are formed in one piece with the stem of the vise. The screw and stem are perforated so that long wires may be inserted through them; and the latter is octangular, so that the whole may be twisted around with the left hand while the

Fig. 6983.



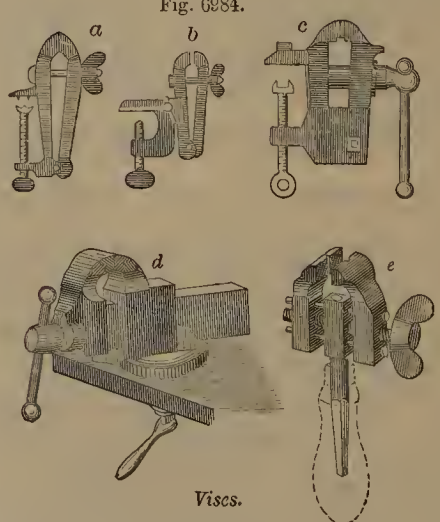

*Hand-Vises.*

right is operating the file. *b c* are hand-vises, also used for holding work while being filed; the latter has a wooden handle. The screws of hand-vises usually have thumb-nuts, but in those of the very largest size square nuts, turned by a key or spanner *d*, are employed.

In Fig. 6984, *a b c* represent table-vises; these are provided with a fixed projecting jaw and a screw, usually toothed at the upper end for holding them on the edge of the work-table.

*d* is a swivel-vise; *e*, a parallel jaw hand-vise.

Fig. 6984.




*Vises.*

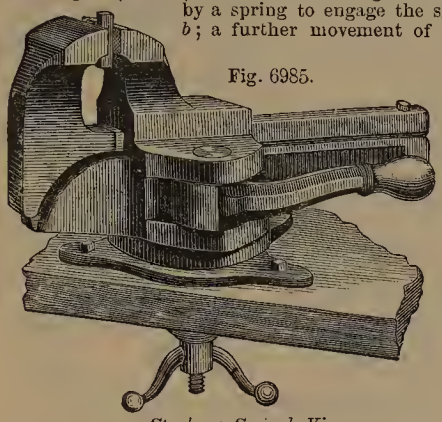
Fig. 6985 illustrates the Stephens vise, being a perspective view of the vise and swivel.

*B* (Fig. 6986) shows a swivel attachment.

*C*, plan of the vise, part of the top being removed to show the working parts. The movable jaw *a* is opened and closed by the

toothed sliding-bar *b*. The lever *c* operates a toggle *d* connected to a toothed piece, which, as the lever is swung round, is forced by a spring to engage the sliding-bar *b*; a further movement of the lever

Fig. 6985.



*Stephens Swivel-Vise.*

brings its end in contact with a cam projection of the toggle, closing the jaw *a* upon the object held by the vise.

*D*, pipe attachment.

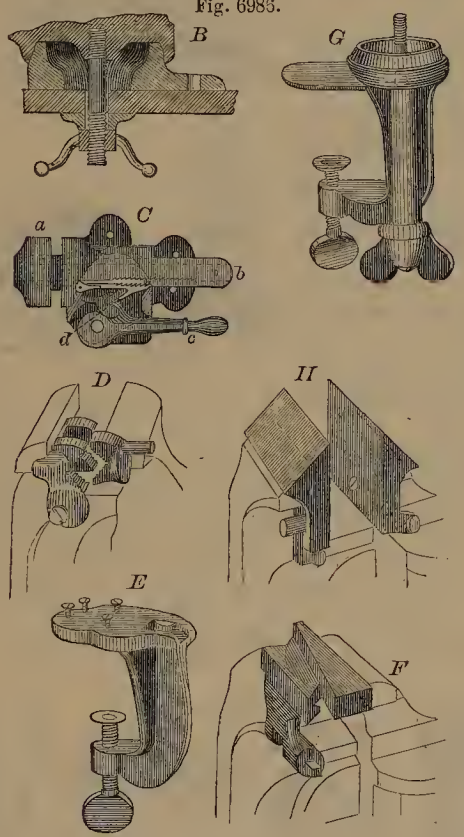
*E*, flat table-clamp for jewelers.

*F*, taper attachment for irregular work.

*G*, jewelers' swivel table-clamp.

*H*, coach-makers', wood-workers', and harness-makers' attachment.

Fig. 6986.




*Stephens Vise and Attachments.*

In the parallel vise (Fig. 6987), the lower end of the movable jaw slides along a guide, and is moved by a screw and hand-wheel as its upper part is opened and closed by the screw which passes through the fixed jaw.

Fig. 6988 is a portable wrought-iron table-vise. The base and table are of cast and the legs of wrought iron.

Fig. 6989 is a handy form of vise for pattern-makers' and saw-filers' use. The jaws are closed by a lever cam and opened by a spring.

2. (*Carpentry.*) A spiral staircase, the steps of which wind around a perpendicular shaft or pillar called a *newel*.

3. (*Plumbing.*) A tool used by plumbers for drawing lead into flat grooved rods, called *cames*, for lattice-windows.

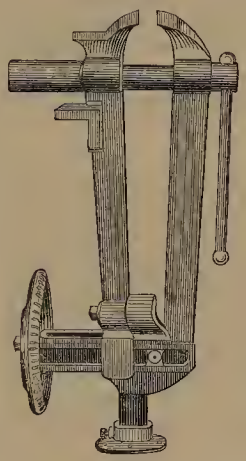
**Vise-clamp.** A supplementary jaw — or, perhaps, we might say, *alveolar process* — to hold pieces of peculiar shape or tender material in the jaws of a vise. See *H*, Fig. 6986.

**Vise-press.** The screw-press — called a vice-press formerly in England — occurs upon the coins of Bostra, in Arabia, and in an illuminated Bible of the fifteenth century. (FOSBROKE.) See SCREW-PRESS.

**Vit're-o-graph.** A photograph on glass.

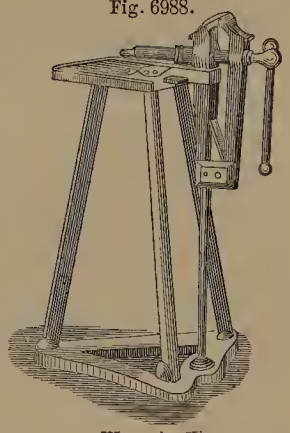
**Vit'rics.** This term includes the fused compounds in which silex predominates, such as glass and some of the enamels; in contradistinction to the *ce-*

Fig. 6987.



*Machinist's Parallel Vise.*

Fig. 6988.

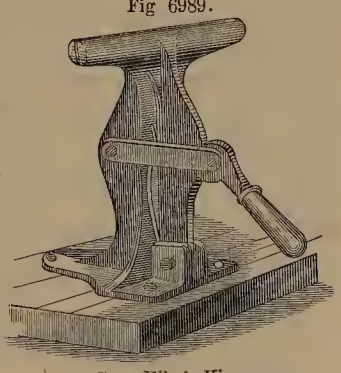


*Wrought Vise.*

*ramics*, in which alumina predominates, such as brick, tiles, pottery, and certain of the enamels.

**Vit-ri-fac'tion.** The act of changing into glass. Said of the melting of silex by heat, — a process which is assisted by the addition of alkalies. *Vitrification.* See GLASS.

Fig 6989.



*Saw-Filer's Vise.*

**Vi'tro de' Tri'no.** (*Glass.*) A kind of Venetian filigree-glass, made of an inner and outer shell, each containing filigree canes, a bubble of air being inclosed at each crossing of the canes. See RETICULATED GLASS; FILIGREE-GLASS.

**Vit'ro-type.** (*Photography.*) A name given to the processes which involve the production of collodion film pictures on glass.

**Vit'ry.** A light canvas. *Vittory.*

**Voic'ing.** (*Music.*) In the construction of organ-pipes, paring away the upper edge of the block in a *wooden mouth-pipe*, opposite to the lip which imparts the vibration to the air issuing from the *plate of wind*. The upper edge is obliquely serrated, to divide the issuing stream of air, the result of which is to prevent a chirping at the commencement of the note.

The voicing of the metallic mouth-pipe is by making parallel notches on the beveled surface of the lip at an angle with the axis of the pipe.

**Vol-can'ic En'gine.** The name applied by its inventor, Oliver Evans, to the aëro-steam engine, in which the heated gases from the furnace are combined with the steam and are unitedly carried to the cylinder. Whether the idea of Mr. Evans proceeded

beyond a mere project is not known to the writer. The distinguished inventor had a very original and practical turn of mind, qualities not always united in the same individual.

An engine of this character was patented in the United States by Bennett in 1838, and was also secured by English patent. The furnace was inclosed in the boiler, and the fuel was burnt under pressure. The smoke and heated gases passed through the water, so as to prevent the passage of grit to the cylinder. See AËRO-STEAM ENGINE.

**Vol-i-cim'e-ter.** A *sea-way measurer*, or self-registering log, was invented by Smeaton. See VELOCIMETER.

**Vol'ta-e-lec-trom'e-ter.** An instrument for indicating the degree of electrical excitation. See ELECTROMETER; GALVANOMETER; VOLTAMETER.

**Vol-ta'ic Bat'ter-y.** An apparatus consisting of pairs of dissimilar metals arranged in a saline or acid solution so as to develop an electric excitation at the expense of the relatively electro-positive metal. See GALVANIC BATTERY.

Volta's first arrangement, invented 1800, was the "pile," consisting of alternate plates of zinc and silver placed one above the other, separated from each other by thicknesses of moistened cloth. To this succeeded the "trough," in which the plates were placed on their edges and liquid substituted for the cloth. Afterward copper was substituted for the silver. Zinc was, and still is, generally used as the positive metal. The negative metal varies in different batteries. Different exciting fluids are also used, as nitric acid or dilute sulphuric acid; the former is employed with the Bunsen and Grove batteries; the latter with most others, bichromate of potash being generally added. A number of formulas are given for the liquid, leading to the conclusion that the proportions may be indefinitely varied within certain limits without material variation in efficiency.

Poggendorff's is 3 pounds bichromate of potash, 4 pounds concentrated sulphuric acid. McCracken's: 1 pound bichromate potash, 3 sulphuric acid, 1 gallon water. Ogden's: 9 bichromate of potash, 40 sulphuric acid, 7 water. Newton: 1 bichromate of potash, 1 sulphuric acid, 12 water. United States Telegraph Company: 6 pounds bichromate of potash, 1 gallon sulphuric acid, 5 gallons water. Western Union Telegraph: 1 saturated solution bichromate of potash, 1 sulphuric acid, 18 water. Prevost's, patent: 800 water, 50 bichromate of potash, 50 sulphuric acid, 2 chromic acid.

**Vol-ta'ic Light.** A light of great intensity, obtained by passing a current of voltaic electricity through two carbon points which are caused to closely approach each other. In practice, a magneto-electric battery is usually employed instead of the voltaic battery. See ELECTRIC LIGHT.

**Vol-ta'ic Pile.** One of the earliest means employed in the production of voltaic electricity.

It consisted of a number of disks of silver or copper, wet cloth, and zinc, in the order named, and this accumulation of positive and negative surfaces produced results much more powerful than had been hitherto attained by any appliances of the new science. It was invented by Volta in 1800.

Fig. 6990.

*Voltaic Pile.*

Zamboni's pile consists of alternate disks of gilded paper and sheet-zinc packed in a glass tube and pressed at each end by metallic plates, which are respectively positive and negative. The disks being dry, the effect is feeble. Two of these piles have been made to oscillate continually a pendulous clapper, which, striking against two bells on the piles, simulated perpetual motion.

Sulzer, in 1767, had noticed that when two pieces of different metals, as copper and zinc, were placed one above and the other below the tongue, an itching sensation, accompanied by a metallic taste similar to that of copperas, was produced.

**Vol-tam'e-ter.** An instrument for measuring the strength of a voltaic current.

In Faraday's (*A*, Fig. 6991), two tubes with closed ends, and containing water acidulated with sulphuric acid, are inverted in a vessel containing the same fluid. In each tube is a slip of platinum connected with one of the poles of a voltaic battery. The current decomposes the water into its elements, which form in bubbles, oxygen upon the positive, and hydrogen upon the negative slip, and thence ascend the tubes. The quantity of gases developed in a given time determines the force of the current. *B* is an enlarged view; *a* being the vessel, and *b* the index-tube. See also GALVANOMETER.

**Vol'ta-plast.** A voltaic battery specifically adapted for the electroplating process.

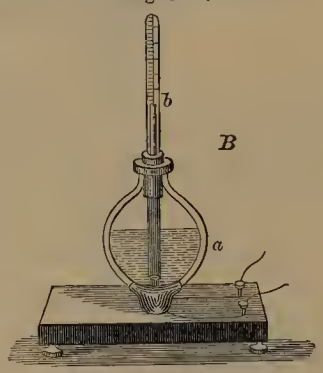
**Vol'ta-type.** A cast of an object obtained by the gradual deposition of a metal from a metallic solution, through the agency of electric action. See ELECTROTYPE.

**Vol'ume** Now, one book of a series or of a collection: as, "a work in three volumes"; "a library containing 2,000 volumes."

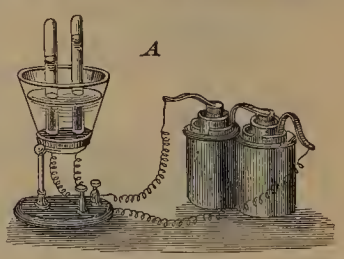
Formerly, *volumen*, a scroll of bark, papyrus, waxed linen, skin, parchment, silk, and, lastly, paper, wound around a stick known as an *umbilicus*, the extremities of which were called the *cornua*, and were tipped in some cases with silver, gold, ivory, or even gems. The author's name was written on a *label* and tied to the *cornua*. The whole was placed in an envelope. They were tinged with oil of cedar-wood, to preserve them from insects.

The specifications of patents at Rolls Court, London, are on very long strips of paper, examined and read by unrolling.

Fig. 6991.




**Vol'u-ta-ry Press.** A transferring-press in which a hardened steel roller or plate, with a design in *cameo* or *intaglio*, is made to deliver an impression upon a plate or roller of a softer material. The harder member forms the *die*, the softer one the *mill*. See TRANSFERRING-MACHINE.




*Voltameter.*

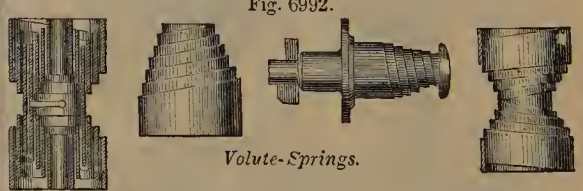
**Vo-lute'.** An ornamental architectural scroll.

**Vo-lute'-com'pass-es.** A draftsman's compasses in which the legs are gradually expanded, so as to trace a spiral.

**Vo-lute'-spring.** A spring of metal coiled in a helix, and extended or extensible in the line of its axis, in which direction its resiliency is utilized.

Fig. 6992 shows several forms, single and double, used in the running gears of cars and for bumpers.

Fig. 6992.



*Volute-Springs.*

**Vo-lute'-wheel.** A volute-shaped shell, that in revolving presents its open mouth to the air, which is thus gathered into the tube and discharged through the hollow axis. It is a common and effective form of blower.

The term *volute*-wheel is sometimes applied to a water-wheel with radial or curved buckets, in which the periphery of the wheel is surrounded by a volute-shaped casing or scroll, which confines the water against the wheel, gradually decreasing in capacity as it encircles the wheel.

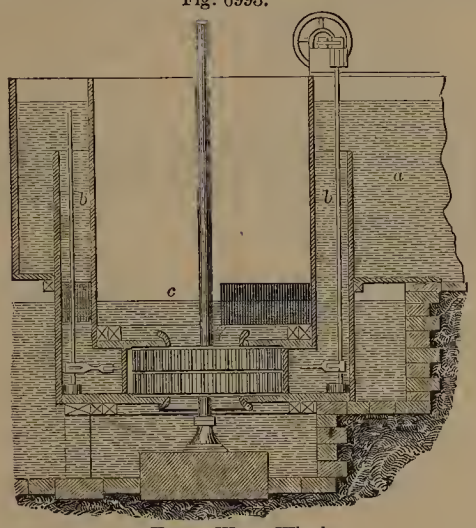
**Vol'velle.** A contrivance of revolving graduated circles for making calculations.

**Vor'tex Wa'ter-wheel.** A kind of turbine in

which the water enters tangentially at the surface and is discharged at the center.

In that illustrated (Fig. 6993), the water from the race *a* flows downward into the chamber *b*, and is conducted centripetally by a series of curved guide-blades to the wheel, whence it

Fig. 6993.




*Vortex Water-Wheel.*

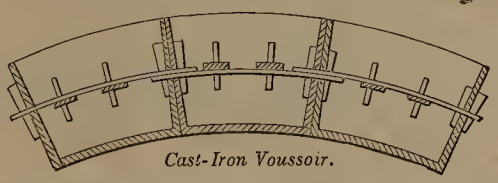
is discharged by two central orifices, one opening upward and the other downward. The portion discharged downward is at once conducted away by the tail-race, while that passing upward into the space *c* is conveyed by suitable channels into the tail-race. The wheel is always completely submerged below the level of the water in the tail-race.

**Vote-re-cord'er.** An apparatus in which, by an impulse given by each member of a body at his desk, upon the "aye" or "no" lever or button, the indication is made at the clerk's or president's desk, and the record counted or sum shown.

In one of the many forms, the members vote simultaneously. There is a dial like a large face of a clock to indicate the *yeas*, and another to indicate the *nays*. These dials contain the numbers of all the members, and each pulls a knob, communicating by a wire, as the bells do in a hotel, with the dial; his number flies out as he pulls, and he sees that his vote is recorded.

By turning a little crank, the hand on the dial is made to point out the number of votes that have been cast both for and against the bill; and by another simple process, the names of those voting both in the affirmative and negative are printed for the use of the clerk on a slip of paper. The whole process of taking the vote, recording it, and printing the name, does not require more than half a minute.

Fig. 6994.



*Cast-Iron Voussoir.*

**Vous'soir.** (*Architecture.*) One of the truncated wedges forming the members of an arch.

Fig. 6994 shows one made of cast-iron.

**Vox Hu-ma'na.** (*Music.*) A reed-pipe stop in an organ, tuned in unison with *open diapason*, and depending for the peculiar quality of its tone, *timbre*, upon the shape of the tube through which the sound of the reed is transmitted. The stop is named from its supposed resemblance to the human voice. See STOP.

**Voy'ol.** (*Nautical.*) A large rope used as a purchase for raising the anchor when more power is required than can be obtained by the use of the messenger. Also written *viol* and *voyal*.

**Voy'ol-block.** A large single-sheaved block for the messenger, which brings the power of the capstan upon the cable.

**Vugh.** A large cavity in a mine.

**Vul'can-ite.** A hard and non-elastic variety of vulcanized rubber, used for making combs, dental plates, and numerous other objects. It contains more sulphur and is subjected to a higher and more prolonged heat in curing than ordinary vulcanized rubber. The invention of Charles Goodyear. (See VULCANIZING.) For special purposes, metals which do not readily combine with sulphur, as gold, platinum, and aluminium, have been combined in a fine state of division with the compound. For instance, see Fowler's patent, 1865, for the combination of vulcanite with aluminium for dental and other purposes.

See also EBONITE, page 771; IVORY, ARTIFICIAL, page 1207; HARD RUBBER, page 1061; CAOUTCHOUC, page 454.

Lamb's patents, November 18, 1873, refer to the vulcanization of other gums and drying vegetable oils, such as those from linseed and cotton-seed. The gums ballata, checkley, and gutta-percha are mentioned. The oil of the *asclepias* is also used.

*Vulcanizing Processes.* See patents: —

| No. | Name and Date. | No. | Name and Date. |
|---|---|---|---|
| 144,998. | Mayall, Nov. 25, '73. | 11,897. | Marcy, Nov. 7, '54. |
| 85,945. | Marquard, Jan. 19, '69. | 17,037. | Herring, Ap. 14, '67. |
| 144,622. | Lamb, Nov. 18, '73. | 7,816. | Trotter, Dec. 3, '50. |
| 144,623. | Lamb, Nov. 18, '73. | 10,586. | Meyer, Feb. 28, '54. |
| 10,738. | Goodyear, Ap. 4, '54. | 56,670. | Cutler, July 24, '66. |
| 24,996. | De Wolfe, Aug. 9, '59. | 37,523. | Roberts, Jan. 27, '63. |
| 23,151. | Beins, March 8, '59. | 24,695. | Eaton, July 5, '59. |
| 23,773. | Mayall, April 26, '59. | 125,707. | Walker *et al.*, Ap. 16, '72. |
| 27,706. | Eaton, April 3, '60. | | |
| 30,807. | Falke *et al.*, Dec. 4, '60. | 26,172. | Eaton, Nov. 22, '59. |
| 27,798. | Harris, April 10, '60. | 153,447. | Meyer, July 28, '74. |
| 23,855. | Parmelee, May 3, '59. | 153,448. | Meyer, July 28, '74. |
| 24,401. | Parmelee, June 14, '59. | 153,449. | Meyer, July 28, '74. |
| 10,339. | Meyer, Dec. 20, '53. | 153,450. | Meyer, July 28, '74. |
| 33,303. | Gately, Sept. 17, '61. | | |

*Coloring Vulcanite.*

99,956. Schlesinger, Feb. 15, '70. | 99,885. Halliday, Feb. 15, '70.

*Vulcanite Articles.* See patents: —

| No. | Name and Date. | Purpose. |
|---|---|---|
| 103,416. | Bird *et al.*, May 24, 1870 | Wringer-rolls, etc. |
| 62,106. | Albright, February 12, 1867 | Harness-trimmings. |
| 77,952. | Beins, May 19, 1868 | Car-springs. |
| 140,519. | Mayall, July 1, 1873 | Belting. |

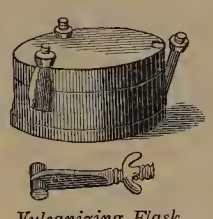
*Restoring Waste Rubber.* See patents: —

| No | Name and Date. | No. | Name and Date. |
|---|---|---|---|
| 15,998. | Forstrick, Oct. 28, '56. | 30,181. | Parmalee, Sep. 25, '60. |
| 122,289. | Smyser, Dec. 26, '71. | 92,764. | Tuttle, July 20, '69. |
| 23,740. | Bachnagel, Ap. 19, '59. | 17,295. | Popenhausen *et al.*, May 12, '57. |
| 25,160. | Hall, August 16, '59. | | |

**Vul'can-ite-flask.** An iron box for holding a denture while being exposed to the heat of a vulcanizer.

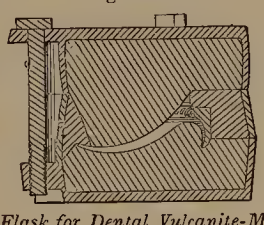
The flask is formed in three parts. The teeth are set in the central part, and the others contain the dies for pressing the rubber into shape. The parts are attached together by bolts.

Fig. 6995.



*Vulcanizing Flask.*

Fig. 6996.



*Flask for Dental Vulcanite-Mold.*

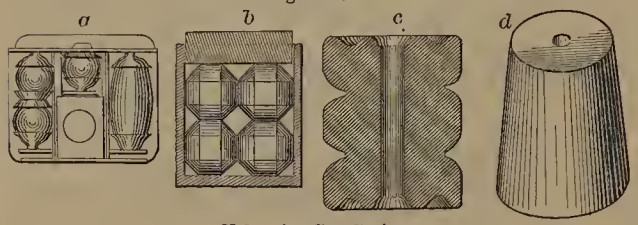
*Vulcanizing Flasks and Molds.*

| No. | Name and Date. | No. | Name and Date. |
|---|---|---|---|
| 39,481. | Howells, Aug. 11, '63. | 73,326. | Hayes, Jan. 14, '68. |
| 30,787. | Hayward, Nov. 27, '60. | 36,146. | Franklin, Aug 12, '62. |
| 84,209. | Moulton, Nov. 17, '68. | 97,266. | Banigan, Nov. 30, '69. |
| 105,971. | Osgood, Aug. 2, '70. | 33,523. | Falke, Oct. 22, '61. |
| 139,579. | Hopkins, June 3, '73. | 28,668. | Hayes, June 12, '60. |
| 115,207. | Hotchkiss *et al.*, May 23, '71. | 23,948. | Roberts *et al.*, May 10, '59. |
| 91,134. | Hurd, June 8, '69. | 112,755. | Weicker, Mar. 14, '71. |
| 140,494. | Gately, July 1, '73. | 41,347. | Alden, Jan. 19, '64. |
| 22,976. | Putnam, Feb. 15, '59. | 53,034. | Parmelee, Mar. 6, '66. |
| 28,428. | Warren, May 2, '60. | 151,779. | Hopkins, June 9, '74. |
| 53,667. | Peer, April 3, '66. | 157,647. | Starr, Dec. 8, '74. |
| 52,107. | Wood, Jan. 16, '66. | 154,082. | Ransom, Aug. 11, '74. |
| 79,816. | Edson, July 14, '68. | 161,656. | Birdsall, April 6, '75. |
| 35,821. | Hayes, July 8, '62. | 170,731. | Heigs, Dec. 7, '75. |

**Vul'can-ite Spring.** Fig. 6997 shows several applications of vulcanite to car-springs.

*a* has metallic cups with vuleanite cushions.
*b* has polyhedral bloeks of vulcanite.
*c* has annular corrugations.
*d*. The bloek is a frustum of a cone.
See also Figs. 1142–1144, pages 482, 483.

Fig. 6997.




*Vulcanite Car-Springs.*

**Vul'can-iz-er.** A furnace in which the flasks containing the dentures are exposed to a heat sufficient to combine the sulphur and caoutchouc, and produce the compound called *vulcanite.*

Fig. 6998.

*S. S. White's Vulcanizer.*

In Hoffstadt's self-regulating vulcanizer, the flame is regulated and the degree of heat indieatcd by the tap of a bell when it has reached the desired point. The gas stopeock is aetuated by a thermostat, whieh eomes into effeetive aetion at a preseribed degree of temperature.

**Vul-can-iz'ing.** The process of combining sulphur with india-rubber to render the rubber insensible to atmospheric changes, increase its durability, and adapt it for various purposes in the arts.

This was originally effected by dipping tho rubber in melted sulphur and heatiug it to nearly 300°. See CAOUTCHOUC.

Several other methods have been employed. In one, the vapor of sulphur, with superheated steam, is brought in contact with the rubber in the mixing apparatus. In Parkes's eold method, the rubber artieles when finished are eleaned, dried, and immersed for one minute in a bath composed of 1 part biehloride of sulphur and 40 parts sulphide of carbou, after which they are quiekly dried in a warm draft. The most usual and probably the best method for general purposes eonsists in mechanically mixing the gum at a moderate heat with flowers of sulphur, and subsequently "euring" it in superheated steam at from 250° to 300° Fah. Other ingredients, as litharge, white-lead, zine-white, and whiting, are added to the sulphur to give eolor, body, and softness to the rubber. See INDIA-RUBBER.

The erude rubber is first plaeed in large tubs and softened by jets of steam, then passed repeatedly between a pair of smooth steel rollers, whieh mash and further soften it, while watcr, triekling from above, washes out the dirt; it is then passed through a mastieating-maehine between a pair of spirally corrugated rollers, water being supplied as before to complete the cleansing, and, eoming out in the form of sheets, is hung in a steam-heated apartment to dry, the longer the better. From the dryiug-room it passes to the grinding-mill, also a pair of steel rollers, heated within by steam, but kept dry on the outside. It is passed repeatedly between these rollers, until it becomes of a uniform doughy consisteney, and is finally delivered in square sheets. The vuleanizing compound is next applied in the mixing-mill, which is very similar to the grinding-mill, the rollers being heated within by steam. The rubber is passed repeatedly between these rollers, while the compound is applied with a trowel or puddling-stick, and becomes equally distributed through the mass. The final heating to complete the proeess is not usually done until the rubber is attached to the eloth which is to receive it, and the artiele of which it forms a part is complete. This is effeeted in cylindrical chambers, the euds of whieh are tightly closed after the articles are introdueed. Live steam is admitted to the interior of the cylinder, which is provided with a system of steam-pipes at the bottom to prevent the free steam around the goods from eondensing.

Car-springs are *cured*, as the process of vulcanizing is teehnically ealled, by placing the crude springs in which the eaoutchouc is mechanically combined with the sulphur, white-lead, whiting, and whatever other material the consisteucy and weight may require, in iron molds, the parts of which are keyed together; and these molds are placed in a boiler, to which live steam is then admitted, the heat being adjusted to the character of result required; from 250° to 300° Fah.

In the curing of material for shoes, a dry heat is usually employed, but steam heat is sometimes used. They are made on lasts, aud placed in raeks on a carriage, whieh is then wheeled into an oven heated by a hard-coal fire. The heat is gradually iuereased, from say 160° at the commencement to 275° at the conclusion, — the process oeeupying about 10 hours of oven heat.

The history of the diseovery of vulcanization is a romance, and has its tragieal features, if a life of hard work, brilliant diseovery, base piracy, and defeated hopes may constitute the elements of a tragedy.

Charles Goodyear, who added a new material to the substances before available for the uses of mankind, was horn at New Haven, Conn., in 1800, and died in New York in 1860. His first discovery in relation to the mode of making india-rubber non-adhesive consisted in dipping the article — a shoe, for instance — in nitric aeid. The effect of this was good, but was only surface-deep. This he patented in 1836, and artieles were thus treated at Providence, R. I., for some years, till the diseovery and introduction of *vulcanization.* 1839 was the date of his diseovery, and 1844 that of his French patent, which was the first publieation of his discovery.

Not satisfied with the nitric-acid process, he appears to have devoted his time and money to experiments of a hypothetical and empirical kind; allying the raw caoutchouc with this, that, and the other ingredient, grindiug, macerating in various solvents and acids. At last, it appears, a piece of india-rubber combined with sulphur was accidentally dropped on to a hot stove, aud the process was revealed. Where it had been slightly warmed, the effeet was but slight; and from this were all the grades of soft and hard rubber, up to the eharring of the materials. The remainder of the inventiou was but a pursuit of various suggestions growing out of the discovery. Materials of many kinds were added to give charaeter, weight, eheapness, eolor; the latter eonstituting artificial ivory or wood, such as *ebonite.* Colored with ciunabar, it formed material for artificial gums and dentures. Innumerable uses occurred, and an enumeration of the number of articles now made of vulcanite would fill a pamphlet.

Goodyear's patent in France was voided hy a tcehnicality, it being held that he had not fully put his inveution iu publie use within the prescribed time. His confidence was abused in England, and a patent obtained in that country a few days prior to that of Goodyear. His patents in this country, 60 in number, have been the cause of interminable litigation, and the inventor died about the time the title was quieted.

His name will ever be remembered as that of a brilliant inventor. So far as personal recognition is concerned, he has his due, but he was mueh pressed in pecuniary matters. Among the well-deserved personal recoguitions may be mentioned the Great Couneil Medal at London, 1851; the Grand Medal of Honor at Paris, 1855; and the Cross of the Legion of Houor from Louis Napoleon.

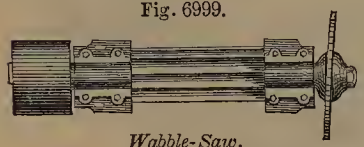
**Vyce.** (*Coopering.*) A gimlet-pointed hand-screw employed to hold up the head while the staves are closed around it.

# W.

**Wab'bler.** An elliptical cutter-head placed at such obliquity on the shaft as to revolve in a circular path. Sometimes called a *drunken cutter*.

**Wab'ble-saw.** A circular saw hung *out of true* on its arbor. Used in cutting dovetail slots, mortises, etc.

Fig. 6999.



*Wabble-Saw.*

**Wad.** 1. (*Fire-arms.*) The wad of a gun is intended to hold the charge in position at the rear of the chamber, or to prevent windage. In small-arms it is usually a disk of felt, punched by a circular wad-cutter. An old felt hat furnishes excellent wads. Plugs of paper, oakum, or cardboard are also used.

2. (*Ordnance.*) Wads for ordnance are of four kinds.

*Junk wads;* made of old rope.

*Grommet wads;* made of cordage, in the form of a ring.

*Papier-maché wads;* small disks for closing the fuse-holes of common shells and the loading-holes of diaphragm shells.

*Coal-dust wads:* serge bags filled with coal-dust, placed inside the 5-pound cartridges for 8-inch guns, to fill up the chamber.

3. (*Mining.*) *a.* Graphite.

*b.* An earthy oxide of manganese.

**Wad'ding.** 1. A spongy bat of cotton wool, made by the carding-machine, and attached by a coat of size to tissue-paper, or treated on one side with a film of glue or gelatine. The name is derived from *ouate* or *wat*, the down of the asclepias, which was formerly imported from Asia Minor for stuffing cushions.

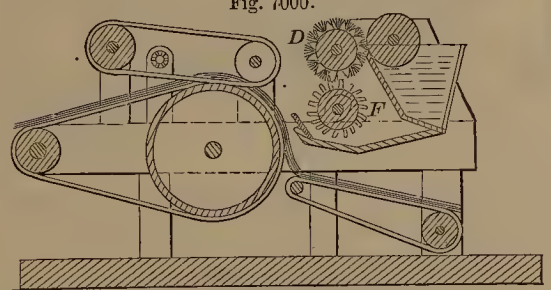
2. (*Fabric.*) Loosely woven stuff used by tailors.

3. Tow for common wads.

**Wad'ding-siz'er.** A machine for giving a coating of size to the surface of a bat of cotton.

The upper reticulated metallic apron is so situated as to exert a pressure upon the sized bat as it passes over the cylinder for the purpose of producing the adhesion of the fibers by means of

Fig. 7000.




*Machine for Sizing Wadding.*

the sizing. The blast-pipe is for the purpose of detaching the bat from the apron.

The rotary cylinder *F* has pin-points or other rigid projections on its periphery, which receive the size from the rotary brush *D*, and sprinkle it upon the bat or web by centrifugal force.

**Wad-hook.** A spiral tool for withdrawing wads. A *worm*.

**Wad'mal.** A heavy, coarse, woolen stuff for sailors' jackets. Made in the Orkneys. *Wadmeil; wadmill; wadmarel.*

**Wad'mill-tilt.** (*Weapon.*) A covering for a field-gun and carriage used in the British service, equivalent to our *paulin*. Length, 14 feet 6 inches; breadth, 11 feet 6 inches; weight, 50 pounds.

**Wad-punch.** A tubular steel punch used for cutting gun-wads, etc. A similar punch is used by leather-workers and others.

**Wa'fer.** A thin adhesive disk used for sealing letters, etc.

Their employment for this purpose is of comparatively modern origin. They are said to have been made in Venice in the sixteenth century. The term is derived from the thin small pieces of bread used in the Eucharist. The Emperor Henry VII. was poisoned by a monk with the mass wafer at Beneventum, 1313.

Fig. 7001.

*Wad-Punch.*

The ordinary kind is made by diffusing fine flour into pure water, forming a thin batter free from clotty particles; this is not allowed to ferment, but is placed between two iron plates, previously greased with butter, which come together like a pair of tongs, leaving a small space between them; and is exposed for a short time to the heat. The plates are then allowed to cool, and, on being opened, the contained sheet is found to be dry, solid, and brittle, and about as thick as a playing card. The wafers are cut from it by annular sharp-edged punches.

Transparent wafers are made by dissolving fine glue or isinglass with such quantity of water that the solution, when cold, shall be of proper consistency: it is poured, while hot, upon a plate of mirror glass, warmed by steam and slightly greased, surrounded by a metallic frame rising just as high above the plate as the wafers are to be thick; on this a second plate of glass, heated and greased, is laid. When the two plates become cool, the gelatine has become solidified, and is cut into wafers with a punch.

**Waf'fle-ir'on.** A cooking-utensil having two hinged portions to contain batter, which is quickly cooked by the relatively large surface of heated iron, owing to square projections which make cavities in the batter-cake.

**Waft.** (*Nautical.*) A flag stopped at the head and middle portions, hoisted as a signal. The meaning of the signal varies according to the place where it is hoisted; at the main, peak, etc. *Wheft.*

**Wag'on.** 1. A four-wheeled vehicle used for goods, freight, and produce, rather than passengers.

The first forms of wheeled vehicles were CARTS and CHARIOTS (which see); the four-wheeled vehicle was much later. It is probable that the word translated *wagon* in our version of the Bible referred to a two-wheeled cart.

The children of Jacob were directed to take "wagons out of Egypt" (Genesis xlv. 19), and many years later (1490 B. C.), in the departure of the Israelites from Egypt, the prince of the tribes offered six covered wagons and twelve oxen, two oxen to a wagon, for the use of the Levites: "two wagons and four oxen he gave unto the sons of Gershom," "and four wagons and eight oxen he gave unto the sons of Merari." — Numbers vii. 3, 7.

Camels are not shown in the Egyptian paintings, and could not have been in common use in that country in Pharaonic times. Their use had long been known in Persia, and some were probably introduced by the immigrating Israelites.

Cambyses failed to reach the oasis and temple of Ammon, probably from want of camels.

Herodotus refers to the carts and wagons of the Scythians (see CART). Æschylus, in his "Prometheus Bound," speaks of the

"Wandering Scyths who dwell
In latticed huts high poised on easy wheels."

One of their wagons, measured by Rubruquis, had a distance of 20 feet between the wheels; the axle was like the mast of a sloop, and it was hauled by 22 oxen, 11 abreast (Fig. 7002).

Marco Polo, who traveled through this country 1275–1295, states that their houses "are circular, and are made of wands covered with felts. These are carried along with them whithersoever they go. They also have wagons covered with black felt so efficaciously that no rain can get in. These are drawn by oxen and camels, and the women and children travel in them. They eat all kinds of flesh, including that of horses and dogs and Pharaoh's rats. Their drink is mare's milk."

Strabo calls the inhabitants of the Don, Mæotis, and Dnieper, *Hamaxæci*, or dwellers in wagons. And Hesiod: —

"To the land of the Galactophagi, who have their dwellings in wagons."

The cut (Fig. 1149) represents modern Tartar vehicles, which probably differ but little from those used on the same steppes twenty-five centuries ago. See CART.

Fig. 7002.

*Scythian Wagon.*

The four-wheeled wagons in the triumphal procession of Ptolemy Philadelphus were of large size; that bearing the image of Bacchus was 14 cubits long and 8 wide, drawn by 180 men. Then followed a wine-press mounted on a four-wheeled wagon 20 cubits long and 16 in width, and drawn by 300 men. The press was full of grapes, and tramped by 60 satyrs, with Silenus as president. Then followed a wagon 25 cubits long and 14 wide, supporting a sack containing 3,000 measures of wine, and consisting of leopards' skins sewed together. This was drawn by 600 men. This wonderful procession is described in the fifth book of the "Deipnosophists," by Athenæus.

The *plaustrum* or Roman wagon is shown upon the column of Trajan. The Scythian, as described by Herodotus, is pictured on page 485. The *plaustrum* had wheels of the same size and a pole. The high-wheeled wagon was derived from the barbarians. It is the *heh hwiolad wæn* of our Anglo-Saxon ancestors. The perch or coupling between the fore and hind axles was added in the Middle Ages.

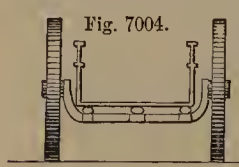
The cumbrous *char* of the fourteenth century was the state-carriage of the time, and was but a wagon. The shafts were fastened to the wagon-body, and the two axles fastened to the bed. Such a carriage must have turned with difficulty, as the fore-carriage was not swiveled. The illustration is from the "Luttrell Psalter," a manuscript of the fourteenth century.

Fig. 7003.

*A Lady's Char of the Fourteenth Century.*

A vehicle on four wheels of equal diameter is of lighter draft than one in which the fore wheels are smaller than the hind-wheels, unless the load is distributed on the wheels in proportion to their diameter. In Baddeley's wagon, constructed in reference to this point, the hind wheels are unusually large, and bear four fifths of the weight when the body is fully loaded. The axle is bent, and the body is supported thereon by three springs, two being used under the fore part.

Fig. 7004.



*Baddeley's Wagon.*

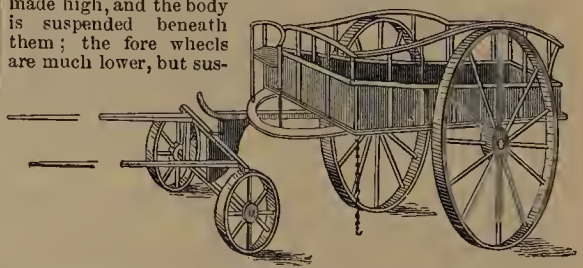
Baddeley contributed a number of papers to the early volumes of the London "Mechanics' Magazine" upon this subject, and is one of those to whom we are indebted for much that is sensible in modern vehicles.

A mongrel contrivance, partaking of the features of cart and wagon, has been suggested. The forward end of a two-wheeled cart is supported upon a fore-carriage, to which the horse is attached. The device needs no lengthy description, as the illustration (Fig. 7005) shows it plainly.

Fig. 7006 is a wagon made with the rear part of its body offset and depending downward below the bottom of the front part. It has also a bent hinder axle placed directly under the rear part of the body. See also TRUCK, Fig. 6676.

Fig. 7007 illustrates a Belgian dray, *a* being a side, *b* a front, and *c* a rear elevation. The hind wheels are made high, and the body is suspended beneath them; the fore wheels are much lower, but sustain comparatively little of the weight. This construction enables very heavy loads to be carried, two horses drawing as much as ten tons. In some cases the body of the dray is more elevated, and casks or cases are slung beneath it by chains, while a heavy load is carried on top.

Fig. 7005.



*Gordon's Wagon.*

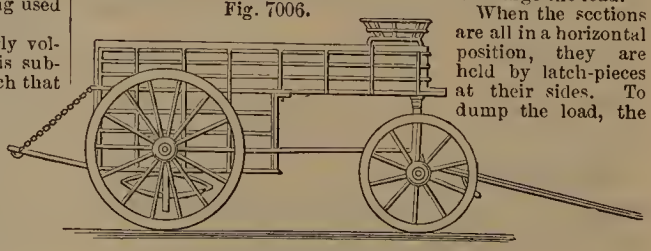
A number of devices have been introduced for dumping the load of a wagon. The Baltimore brick wagons are made to travel back on rollers over the hind axle until they upset and discharge the load.

Other wagons have trap-doors in the bottom.

Others are made in sections so pivoted as to careen singly or simultaneously.

Robinson's dumping-wagon has a body composed of separate sections arranged in line with each other and pivoted to the bed-pieces of the wagon-frame, so as to be placed in a horizontal position to hold the materials, or tilted, rear end downward, to discharge the load.

Fig. 7006.



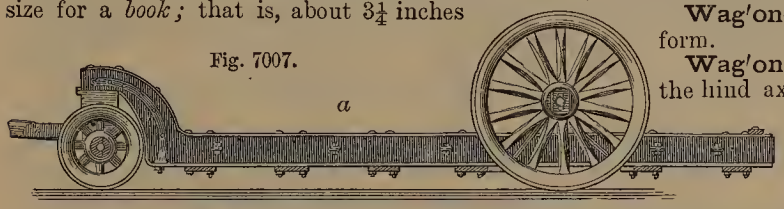
*Express-Wagon.*

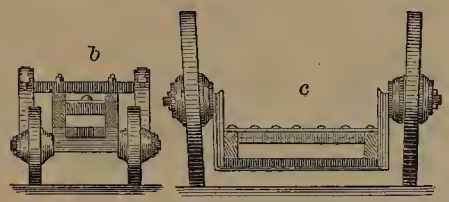
When the sections are all in a horizontal position, they are held by latch-pieces at their sides. To dump the load, the

sections are disconnected and tilted, as indicated in the figure.

2. A tool having four edges of cane mounted in a frame, and used to trim the edges of gold-leaf to a size for a *book;* that is, about 3¼ inches

Fig. 7007.



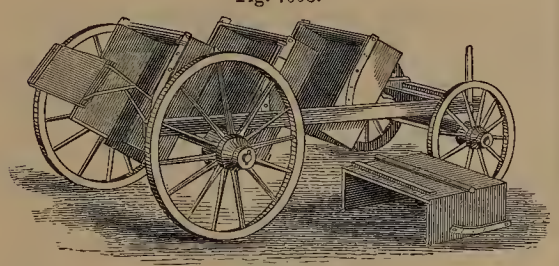

*Belgian Dray.*

on a side. A *book* consists of 25 leaves of gold interposed between paper leaves. The cane is used in preference to steel, as the gold does not adhere to it.

**Wag'on-boil'er.** (*Steam-engine.*) A boiler having a semicircular top and flat or concave bottom; so called from the resemblance of its shape to that of a wagon covered with its tilt. See *A*, Plate LXI.

It is always set up with a *wheel-draft;* that is, the current of flame and smoke after passing under the boiler-bottom is made to rise up at the back, whence, returning along one side by a brick flue to the front, it crosses the front end, and thence passes along the other side to the back, where it enters the

Fig. 7008.

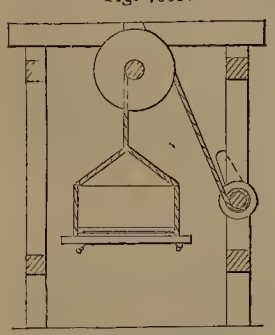


*Dumping-Wagon.*

main flue, which conducts it to the chimney. Wagon-boilers were formerly very generally used in the manufacturing districts of Yorkshire and Lancashire. The usual sizes were 16 to 24 feet long, 6 feet 8 inches deep, and 5 feet wide; each foot in length was considered as capable of supplying steam for 1 horse-power of the engine, a 20 horse-power boiler being 20 feet in length. In one of this size, the fire-grate is 5 feet long and 4 feet wide, the grate-bars usually having a fall of 3 or 6 inches from front to back.

**Wag'on-bow.** An arched-shaped slat with its ends planted in staples on the wagon-bed sides. Used to elevate the tilt or cover.

Fig. 7009.



*Wagon-Box Lifter.*

**Wag'on-box Lift'er.** A hoisting device to elevate the wagon-bed from the running gears when the latter are required to hold the hay-frame, or are to be used without any bed, for hauling rails, etc.

**Wag'on-brake.** A carriage-brake is a frictional device applied to the wheels of a vehicle in order to retard its motion when descending a hill. It is usually called a *wagon-lock* in the United States; and though the term *brake* is eminently appropriate, to avoid repetition the subject will be considered under WAGON-LOCK (which see).

**Wag'on-ceil'ing.** One of a cylindrical form.

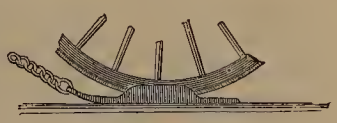
**Wag'on-coup'ling.** One for attaching the hind axle to the fore. Known also as a *reach* or *perch* in carriages.

**Wag'on-drag.** A shoe secured by a chain to the bed or coupling of the vehicle, and forming a temporary runner which receives the weight of the wheel, and by friction on the ground arrests the speed of the vehicle in going down hill.

In the United States, a *lock* is preferred. See WAGON-LOCK.

In its simple form, it is a cast-iron shoe to receive the wheel, being secured by a chain to some part of the vehicle, so as to *drag* thereby. It is suspended to a hook on the carriage when not in use.

Fig. 7010.



*Drag.*

Kneebone's drag (English) is curved to the contour of the wheel, and is anchored to the carriage by a chain of such a length as to allow the wheel to run up on to it when detached from its suspensory hook on the carriage for that purpose. It has a roller in front, which diminishes its friction on the ground and throws the wear on the rear part of the shoe.

Fig. 7011.

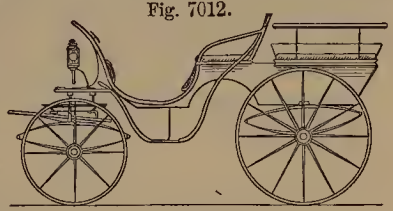
*Kneebone's Drag.*

**Wag'on-ette'.** (*Vehicle.*) A kind of four-wheeled pleasure-vehicle of very light construction.

**Wag'on-ham'mer.** The vertical bolt which connects the *double-tree* to the tongue, and upon which the *double-tree* swings.

It is made in the form of a hammer for the sake of convenience, being withdrawn from its place in the double-tree when required for any purpose. The end of the shank is tapered off, and is used in lifting the linch-pin to remove a wheel.

Fig. 7012.



*Wagonette.*

With thimble-skein wagons (see AXLE-SKEIN), in the place of the hammer-head is a wrench for removing the nut from the end of the spindle.

**Wag'on-head'ed Ceil'ing.** One having a cylindrical form.

**Wag'on-hoist.** An elevator used in carriage-factories, depots, and livery-stables to raise or lower vehicles to or from floors in the building. The platform is balanced by weights from pulleys over the respective corners, and is operated by hand-rope, drum, and spur gear.

Fig. 7013.

*Wagon-Hammer.*

**Wag'on-jack.** One for lifting the wheels of a wagon clear of the ground, that the wheels may be removed and the spindle greased. The varieties are numerous. See CARRIAGE-JACK; LIFTING-JACK; etc. See list under JACK, page 1208.

**Wag'on-lock.** A device to bring a friction on the wheels of a wagon to retard its motion in descending hills.

In Fig. 7014, the rubber *H* is brought, by means of lever, cord, and crank-shaft, to bear upon the wheel.

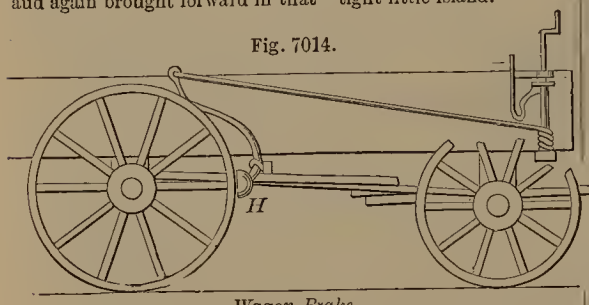
In Fig. 7015, the self-locking lever engages the guide segment by friction, being impelled thereto by the spring upon the op-

erating lever. The friction is relieved by drawing toward the main lever.

In Fig. 7016, the holding back of the horses in descending a hill pulls upon levers at the end of the tongue and operates the rubber levers. There are very many different methods.

Though the friction-lock has never been adopted in Britain to the same extent as in the United States, they have been again and again brought forward in that "tight little island."

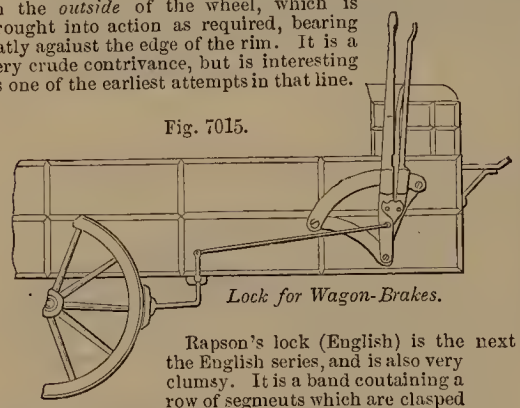
Fig. 7014.




*Wagon-Brake.*

Lord Somerville's friction-lock (called a drag) consists of a bar on the *outside* of the wheel, which is brought into action as required, bearing flatly against the edge of the rim. It is a very crude contrivance, but is interesting as one of the earliest attempts in that line.

Fig. 7015.

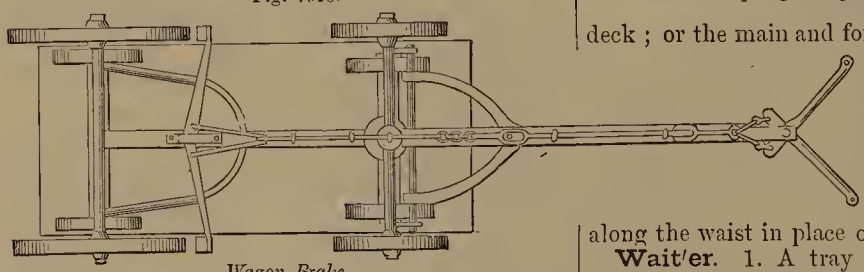


*Lock for Wagon-Brakes.*

Rapson's lock (English) is the next in the English series, and is also very clumsy. It is a band containing a row of segments which are clasped around a collar on the hub when the motion of the wheel is to be impeded or arrested. Several modes of bringing the affair into action are suggested. In one, the breeching-straps of the horse pass through staples on the shafts and thence back to the brake-band, so as to pull on the latter when the horse holds back.

**Wag'on-seat.** One perched on the wagon-bed, as in Fig. 7020, or supported from the standards, as in Fig. 7019.

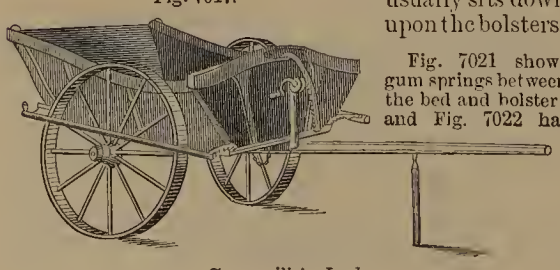
Fig. 7016.



*Wagon-Brake.*

**Wag'on-spring.** Excepting in that kind of driving-buggy known as a *wagon*, or the *wagonette*, the wagon-bed usually sits down upon the bolsters.

Fig. 7017.



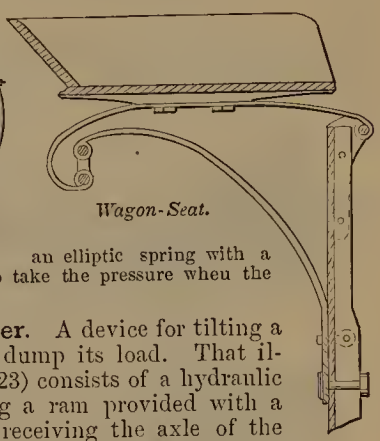
*Somerville's Lock.*

Fig. 7021 shows gum springs between the bed and bolster; and Fig. 7022 has an elliptic spring with a caoutchouc sphere to take the pressure when the load is extreme.

Fig. 7018.

*Rapson's Lock.*

Fig. 7019.



*Wagon-Seat.*

**Wag'on-tip'per.** A device for tilting a wagon in order to dump its load. That illustrated (Fig. 7023) consists of a hydraulic lifting-jack having a ram provided with a head suitable for receiving the axle of the car, which is run over it, and that end lifted by operating the pump.

**Wag'on-tongue Sup-port'er.** See TONGUE-SUPPORT.

**Wain.** A wagon.

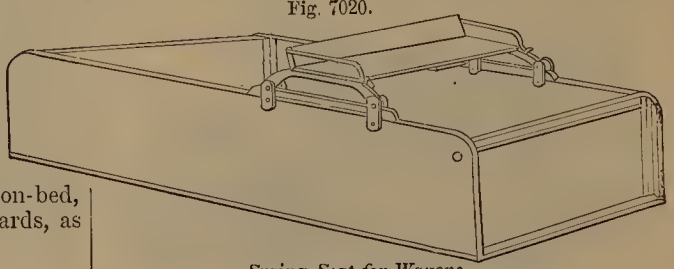
**Wain'scot.** (*Carpentry.*) A paneled facing to interior walls. It was common formerly, but other modes of finishing interiors have superseded it. *Wainscoting.* It is again coming into use.

So called from a foreign species of oak called *wainscot* having been formerly applied for the purpose.

**Waist.** 1. A narrow portion of an object, as the contracted part of a Smeaton lighthouse.

2. (*Nautical.*) The middle portion of an object, as the midship part between the forecastle and quarter-

Fig. 7020.



*Spring-Seat for Wagons.*

deck; or the main and fore hatchways; or the half-deck and galley.

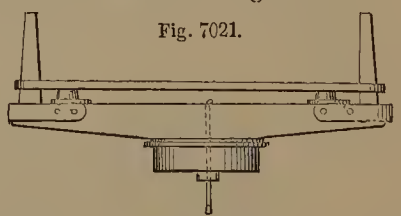
**Waist-block.** A bulwark sheave in the waist of the vessel.

**Waist-tree.** (*Nautical.*) Another name for a *rough-tree* or spar placed along the waist in place of bulwarks.

**Wait'er.** 1. A tray on which to carry plates, etc., or offer food to guests.

2. A revolving or traveling table or tray to bring the dishes within the reach of guests.

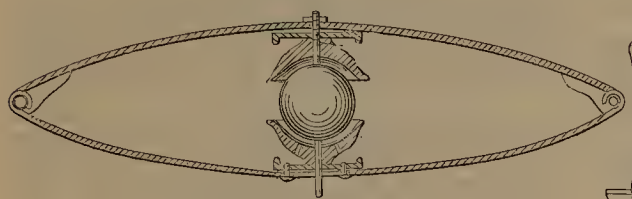
Fig. 7021.



*Wagon-Spring.*

3. An elevator. See DUMB-WAITER; ELEVATOR; HYDRAULIC ELEVATOR; ROPE-ELEVATOR; WATER-ELEVATOR. See also list under HOISTING.

Fig. 7022.



*Wagon-Spring.*

**Wale.** 1. (*Shipwrighting.*) A wide plank at certain portions of a ship's side, extending from stem to stern and describing the curve of the *strakes*. The wales are known as the *main-wale*, *gunwale*, *channel-wale*, etc.

The *channel*-wale of a man-of-war is below the lower deck-ports, and the *main*-wale between the ports of the respective decks.

2. A timber bolted to a row of piles to secure them together and in position.

**Wale-piece.** A horizontal timber of a quay or jetty, bolted to the vertical timbers or secured by anchor-rods to the masonry to receive the impact of vessels coming or lying alongside.

**Walk'er-bit.** (*Saddlery.*) A milder type of Mexican bit, but yet retaining its leading characteristics.

**Walk'ing-cul'ti-vat'or.** One in which the operator walks behind, as distinguished from the *riding* or *sulky* cultivator.

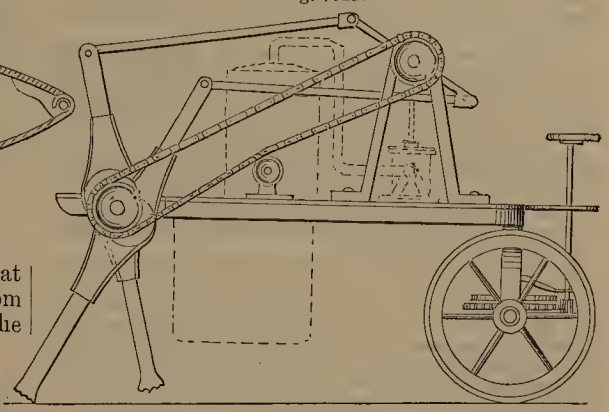
Fig. 7024.

*Walking-Cultivator.*

**Walk'ing-ve'hi-cle.** One in which the progression is made by the recurrent action of oscillating rods which step upon the floor or ground.

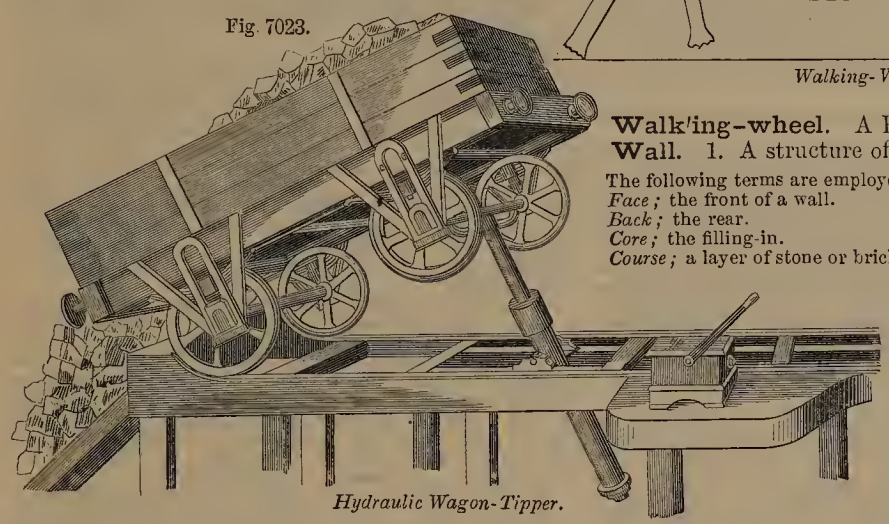
The legs are operated by cranks turning on eccentrics, by which they are raised during their forward movement and depressed during their effective stroke.

Fig. 7025.



*Walking-Vehicle.*

Fig. 7023.



*Hydraulic Wagon-Tipper.*

**Walk'ing-wheel.** A PEDOMETER (which see).

**Wall.** 1. A structure of stone or brick.

The following terms are employed: —

*Face;* the front of a wall.

*Back;* the rear.

*Core;* the filling-in.

*Course;* a layer of stone or brick. See COURSE.

*Bond;* the system of laying. See BOND.

*Batter;* the slope of the face (if any).

*Party-wall;* one common to two houses.

*Flank-wall;* a *return* or side wall.

Fire-proof walls are made of stone, brick, or metal, but the resisting power of brick is greatest. Granite splits and flies, sandstone scales, limestones and marble crumble into lime, iron warps and melts. This subject has been considered, briefly, under FIRE-PROOF BUILDING, and here there is but room for a few examples of the uses of iron in forming, strengthening, or facing walls.

*A* is for an inside wall, having studs *a* of corrugated sheet-metal for supporting a lath surface *b*, whose inturned edges occupy slots in the edges of the stud-plate.

*B* has studding and frame of angle-iron *c*, with panels of iron lattice-work *d*, which is covered in entirely by concrete material *e*.

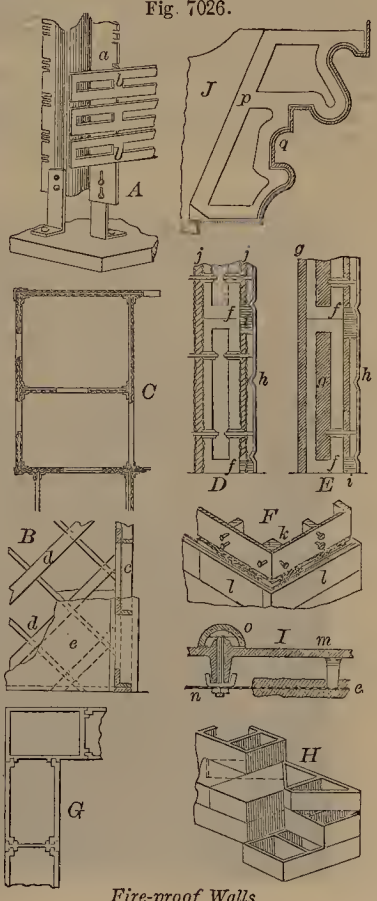
*C* represents on a small scale one or two rooms of a house constructed on Seely's plan, with corrugated sheet-metal and angle-iron.

*D* has an open framework of metallic sections *f*, with sides of double wire gauze *j*, inclosing plaster of Paris, and with an outer sheathing of metal *h*, in imitation of masonry, isolated from the frame by soapstone blocks *i*.

*E* has a filling of concrete *g* around the frame *f* and the sheathing *h* and blocks *i*, just described.

*F* has a wooden frame *k* with a con-

Fig. 7026.




*Fire-proof Walls.*

crete outside the sheathing, and an outside wall of artificial stone *l* made with dovetails at the rear, which form locks in the concrete.

*G* has east-iron hollow boxes, made with tongues, grooves, lugs, and locking-plates. These are built together in their courses, and the courses fastened together in a similar manner.

*H* uses east-iron, hollow, rectangular, or triangular blocks, and builds them up in the manner of bricks.

*I* is specially intended for mansard roofs; it has an outer iron plate *m* and inner wire-gauze *n*, on which the plaster *e* is spread. *o* is an outer break-joint plate to cover the junction of the plates, and its bolt locks all the parts together.

*J* shows a sheet-metal cover *q* to a cast-iron bracketing *p*, the whole forming a cornice.

The "formacean" walls, described by Pliny, were "molded rather than built," as he says, "by ramming earth within a frame of boards, constructed on either side." He declares them very lasting, and refers to the earthen watch-towers erected by Hannibal on the summits of the mountains in Spain. "The earth so rammed, I can assure you, does continue for years in an imperishable state, and is neither affected by rain, by wind, nor by fire, and neither mortar nor cement is used in them." These must have been what are now termed PISÉ-WORK (which see).

Ransome's process (English) for rendering walls impervious to moisture is as follows: —

The external surfaces of the walls to be protected are first washed with a silicate of soda or solution of flint, which is applied again and again, until the bricks are saturated, and the silicate ceases to be absorbed. The strength of the solution is regulated by the character of the bricks upon which it is to be applied, a heavier mixture being used upon porous walls, and a lighter one of those of denser texture. After the silicate has become thoroughly absorbed, and none is visible upon the surface, a solution of chloride of calcium is applied, which, immediately combining with the silicate of soda, forms a perfectly insoluble compound, which completely fills up all the interstices in the brick or stone, without in any way altering its original appearance. By this operation the wall is rendered perfectly water-tight, and, as the pores of the bricks are thoroughly filled for a considerable depth from the surface with the insoluble compound, which is entirely unaffected by atmospheric influences, no subsequent process is necessary.

*Cob walls*, still used in some rural districts of Britain, are made of clay and chopped straw, based upon brick or stone foundations, and having a thickness of about two feet. They are built in the manner of PISÉ-WORK (which see). In some cases, however, the work is not confined within boards, but is built up by the shovel, being well incorporated before applying and after placing it on the wall. The lintels and sills of the doors and windows are built in, but the openings are cut subsequently. As each layer dries its surface is shaved and trimmed, receiving a final coat of plaster.

Straw houses are made in England by an inventor who proceeds as follows: —

He compresses straw into slabs, soaks them in a solution of flint, to render them fire-proof, coats the two sides with a kind of cement or concrete; and of these slabs the cottages are built. By ingenious contrivances, the quantity of joiner's work is much reduced, and the chimney is so constructed as to secure warmth with the smallest consumption of fuel, and at the same time to heat a drying closet. The cost of a single cottage of this description, combining "all the requirements of health, decency, and comfort," is $425. See also list under MASONRY.

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The walls of Babylon were possibly 75 feet high. They had been gradually decreasing in height since the time of Herodotus, who reported them 200 royal cubits = 337 feet (English); Ctesias, 300 feet; Xenophon, 100. It is probable that the reputed dimensions decreased as more reliable estimates were transmitted.

The Chinese wall was built by Chi-hwang-ti, 220 B. C. The feudal system was about that time in course of demolition in China, and was accomplished by the Han dynasty. The process is now being repeated in Japan.

This great wall is 1,200 miles long, from 20 to 25 feet high, and from 15 to 20 feet broad.

It was built as a barrier against the hordes of Tartar cavalry, and was everywhere constructed of the materials found in the immediate neighborhood.

Fig. 7027 is a view of a portion of the Great Chinese Wall, at a point three days' journey from Pekin, on the route to Siberia.

On plains and terraces which afforded clay and loam, it was formed with an earthen core, built up in well-pounded layers, growing narrower toward the top, and faced with large tiles laid flat. The top was also paved with tiles and defended with a parapet. On mountains of stratified rock the facing was made of masonry, and the interior filled with earth and cobble-stones. On the mountain of Kal-gan, where the rock is a trachytic porphyry, which breaks only into most irregular shapes, the wall is of solid masonry, the stones being laid in cement; its section is here an isosceles triangle, the crest being brought to a sharp edge.

In other localities it is built of hewn rock, and has a brick parapet. Where it ascends a mountain the top is built into steps to facilitate the passage of soldiers. Throughout its entire length it is defended by towers, which rise from it at regular distances of a few hundred feet. Many of these towers are several stories high, and are provided with loopholes and with arched windows. In many places the northern side was defended with ditches and embankments, which may originally have existed throughout the whole length of the wall, or they may have been constructed to resist local attacks.

Every mountain pass and every weak point was defended by a fortified town. The wall is now in very different states of preservation, according to the material used. In the valleys, the points where it was originally most needed, it has crumbled into a mere line of rubbish, which is being rapidly graded down by the plow.

The Abbé Hue says of the Chinese wall, that one of the embassy of Lord Macartney in 1793 estimated the cubic masonry of the great wall was greater than that of all the houses in England and Scotland. "But it is evident that he has taken for the basis of his calculation the part of the wall immediately to the north of Pekin, which is really fine and imposing, but it must not be supposed that this barrier is equally large and solid throughout its whole extent. We have had occasion to cross

Fig. 7027.

*The Great Chinese Wall: the Nang-Kao Pass.*

it at more than fifteen different points, and have often traveled for days together without ever losing sight of it; and, iustead of the double-battlemented stone-wall which is seen at Pekin, it is sometimes a very humble-looking wall of clay; and we have even seen it reduced to its simplest expression, and composed only of stones piled up together."

It appears that it suffered the fate so common to contract work; well done at special points, and "the mere pretense of a wall ou those distant points, which had besides little to fear from the Tartars, — such, for instance, as the frontiers of Ortons and the Alechan Mountains." — Huc.

For information of the construction of Roman walls see "Murus"; "Paries," in Smith's "Dictionary of Greek and Roman Antiquities."

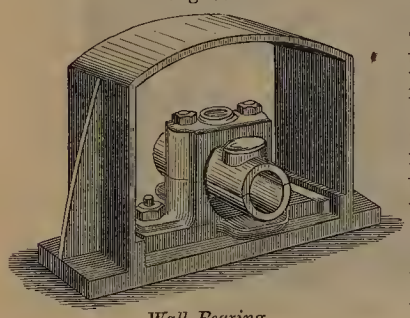
2. (*Mining.*) The rock inclosing a vein. The upper and lower portions are known as the *roof* and *floor* respectively.

Where the *dip* is considerable, the upper boundary is the *hanging-wall*, and the lower the *foot-wall*.

3. (*Nautical.*) A large knot worked on the end of a rope; as of a man-rope, for instance.

**Wall-bear'ing.** (*Machinery.*) A bearing for receiving a shaft when entering or passing through a wall. It is protected by a cast-iron casing, built into the wall, the bottom of which serves as a bed-plate for the plummer-block, the upper part supporting the masonry above. A *wall-box*.

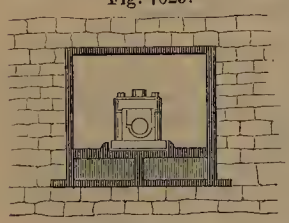
Fig. 7028.



*Wall-Bearing.*

**Wall-box.** (*Machinery.*) A device for supporting a plummer-block in which a shaft rests in passing through a wall.

Fig. 7029.



*Wall-Box.*

It consists of a rectangular cast-iron frame, having arrangements for receiving and holding the box in fixed position.

**Wall-clamp.** A brace or tie to hold walls together, or the two parts of a double-wall, to prevent spreading.

**Wall-desk.** A sort of bracket-desk attached to a wall.

**Walled A'rea.** (*Metallurgy.*) *a.* An ore-roasting space inclosed by three walls, or by four, with the exception of a doorway.

*b.* A *patio*. See Fig. 138.

Fig. 7030.

*Wall-Desk.*

**Wall-knot.** (*Nautical.*) A large crowning-knot worked upon the end of a rope.

**Wal'low-er.** A lantern-wheel. A wheel made with two end disks attached to the shaft, and a series of rounds or trundles connecting the disks and acting as cogs. A trundle-wheel.

**Wall-pa'per.** Paper prepared for hanging upon walls to render them more sightly; or merely for the purpose of coloring them, as in photographic studios; the rooms in hospitals devoted to eye-diseases, etc. Great improvements have been made of late both in the quality of the material and its ornamentation.

Paper-hangings were first attached in the stead of silk or tapestry, about A. D. 1555. They were made by the Spanish and Dutch, and ornamented by stamping, or stenciling *velvet* or *flock* paper in which the surface was ornamented with silk or floss, by Lanyer, who obtained a patent therefor in the reign of Charles I., about 1634. He called the product *Londrindina*, and states that he had "fouud out au art for affixing wool, silk, and other materials upon linen, cotton, leather, and other substances, with oil, size, and cements, so as to make them serviceable for hangings and other purposes."

His claim to priority was disputed, and it was stated to have been invented in 1620 by François of Rouen, where the business was carried on by father and son till the death of the latter, in 1748. Wooden blocks for printing the patterns in size were exhibited during the dispute.

Nemetz describes the manufacture of "wax-cloth hangings with wool chopped and beat fine" to one Andran, a Frenchman, early in the eighteenth century. This artist was inspector of the palace of Luxembourg, was celebrated for his arabesque and grotesque paintings, and had a manufactory of hangings in the palace.

Savary, in his "Dictionary of Commerce," states that flock-hangings were first made at Rouen, but they do not appear to have had a paper backing. In the early part of the eighteenth century paper-hanging was of such poor quality as only to be used in houses of inferior class, but toward the end of that century the manufacture had attained excellence, and the best mansions were decorated with it. In 1786 the art is declared by Temple to have culminated in point of excellence in design.

The mode of making the paper-hanging in continuous lengths was subsequently introduced.

Breitkopf, of Leipsic, Germany, introduced the imitations of marble, porphyry, and other masonry.

The addition of a metallic dust to give brilliancy to the design on the paper seems to have originated some two centuries since. Hautsch, of Nuremberg, invented the mode of preparing the metallic dust, which was soon adopted by the wall-paper manufacturers. (See Metallic Dust.) Eccard is also credited with being the first to make tinsel-paper with the "metallic dust."

Black and white mica (*Glimmer*) were also used in Germany for this purpose in the seventeenth century.

In *block-printing*, wooden blocks are prepared by cutting away the portions which are not designed to print, or pieces of metal, forming the pattern, are inserted. These are dipped in the color and laid on the paper, which has been previously covered with a thin coating of color serving as a ground. In the cheaper kinds a colored paper is used to print on.

The greater proportion of wall-papers are now printed in a manner entirely analogous to calico-printing by being passed through a series of engraved cylinders heated and rotated by steam-power, which dry the color very rapidly, and perform the whole work with such expedition that the plain paper, as it comes from the mill, may be printed and reeled ready for use in half an hour.

Paper-hangings, printed from cylinders, were exhibited by Zuber of Mulhausen, at the eighth French Exposition of Industry, 1834.

By using a sufficient number of cylinders, from 12 to 20 colors are applied to the paper during its passage through the machine.

Of late years thin veneers of wood have been introduced to some extent in lieu of wall-papers.

Wall-papers are sometimes printed with varnish or size, and gilt or copper leaf applied; or pulverized bisulphide of tin is dusted over so as to adhere to the pattern. In flock-papers finely comminuted wool dyed of the desired color is similarly used. Powdered steatite or French chalk is used as the ground for satin papers, the gloss being produced by polishing. Stripes are sometimes produced by passing the paper rapidly under a trough having parallel slits in its bottom. Previous to the introduction of machinery, the size of the sheets of wall-paper was necessarily limited to that of the old hand-mold. At present they are made in lengths of 12 yards, having a width of 20 inches when hung, and covering 60 superficial feet. The number of pieces therefore required to cover a surface is ascertained by dividing the number of superficial feet which it contains by 60.

**Wall-pa'per Cut'ter.** A machine for trimming the edges of wall-paper.

The paper is laid with its margin projecting over the edge of the table. A wheel running on the paper communicates its motion to a pair of cutting-wheels, between which the paper is passed.

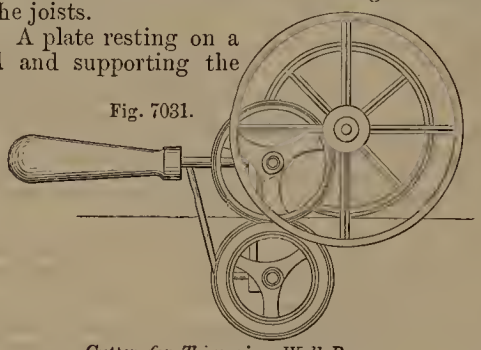
**Wall-pa'per Hang'er.** A device for hanging wall-papers.

The end of the sheet is carried around a roller, and is held by a clamping-bar maintained in closed position by a spring acting on arms; when the paper is applied its end is released by pulling a trigger, and the roller is then employed for pressing the surface of the paper in order to cause its adherence to the wall.

**Wall-plate.** 1. (*Building.*) *a.* A piece of timber let into a wall to serve as a bearing for the ends of the joists.

*b.* A plate resting on a wall and supporting the

Fig. 7031.

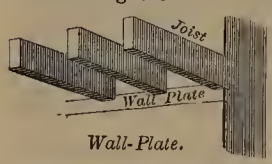


*Cutter for Trimming Wall-Paper.*

frame of the roof. See KING-POST TRUSS. Called also *raising-plates.*

2. (*Machinery.*) The vertical back plate of a plummer-block bracket, for attachment to the wall or post. See BRACKET.

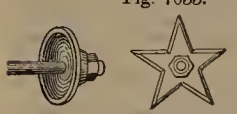
Fig. 7032.




*Wall-Plate.*

**Wall-sid'ed.** (*Nautical.*) Said of a ship with upright sides above the water-line; in contradistinction to the term *tumbling home*, in which the ship bulges below, and has less beam at the upper deck than at the water-line.

Fig. 7033.



*Wall-Washers.*

**Wall-wash'er.** A large plate at the end of a tie-rod to extend the external bearing. They are known as *bonnets, stars, S's,* according to shape.

**Wa'ney.** The feather-edge or acute angular edge of a slab-board, cut from a round log without previous squaring, or obtained in the process of squaring.

The *edges* remove the *bark* and *waney* from a board.

**Want'y.** (Dan. *Want*, cordage.) A rope or strap to bind a load on the back of a horse. Used in hilly countries, and by cavalry when foraging. A *surcingle.* A *wagon-rope.*

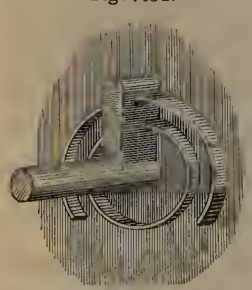
**Wapp.** (*Nautical.*) A leader on the end of a pendant, acting as a fair-leader.

**Ward.** (*Locksmithing.*) *a.* A curved ridge of metal inside a lock which opposes an obstacle to the passage of a key which is not correspondingly notched.

Warded locks were used by the Romans, as the keys found at Herculaneum and Pompeii sufficiently testify. The character of the ward frequently gives the name to the lock, as, —

*One-ward* or *two-ward lock.* The wards, being usually of sheet-metal bent into a round form, are sometimes called wheels; hence the names *one-wheel, two-wheel* locks, etc. When the wards are cast solid, instead of being made of bent strips, the lock is a *solid ward.*

Fig. 7034.



*Lock-Wards.*

The shape of the ward sometimes gives the name, as L-*ward*, T-*ward*, Z-*ward*, etc

A lock without *wards* is a *plain lock.*

*b.* The notches or slots in a key are also called key-*wards*, somewhat in violation of the meaning of the term: *ward*, a guard.

**Ward'ing-file.** A flat file having a constant thickness, and only cut upon the edges. Used in filing the ward-notches in keys.

**Ward-room.** (*Nautical.*) A cabin, on board large ships-of-war, for the accommodation of officers ranking as lieutenants.

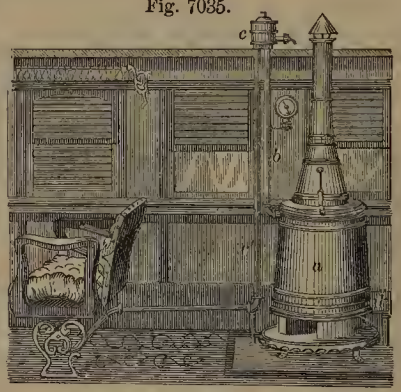
**Ward's Case.** An air-tight inclosure with glass sides and top for preserving or transporting plants, etc.; named from the inventor.

Mr. Hooker, the naturalist, records that in 1850 the superintendent of the Calcutta Botanic Gardens received 391 plants from North America, packed and transported in ice, in excellent order. They consisted of varieties of trees, bushes, and plants, fruit and ornamental, and were packed in Ward's cases for transportation to the English settlements in the Himalaya Mountains.

**Warm'er.** A heating device. See list of STOVES and HEATING APPLIANCES, pages 2409, 2410.

Fig. 7035 is an apparatus for warming railway-cars by means of hot water, which is heated in an annular boiler *a* surrounding the stove, passes through an upwardly ascending pipe *b* into the small tank *c*, whence it descends through the pipe *c'*, and is conveyed by a horizontal pipe beneath the seats of the car, and is finally returned to the lower part of the boiler by the pipe *d.*

Fig. 7035.




*Baker's Car-Warmer.*

**Warm'ing-pan.** A brazier with hot coals for airing and warming a bed.

"January 1st. Presented from Captain Beckford with a noble silver warming pan." — PEPYS's *Diary*, 1669.

"Never mind the warming-pan." — PICKWICK.

**Warn'ing-piece.** (*Horology.*) An oscillating piece in the striking parts of a clock which is actuated by a pin on the hour-wheel, so as to release the *fly* which regulates the speed of striking ready for the lifting of the *hauk's-bill* detent in the *rack.* The *warning-piece*, by starting the fly, causes a rustling noise, which is the precursor of the *striking*, and is called the *warning.*

**Warn'ing-wheel.** That wheel in a clock which produces an audible sound at a certain distance of time before striking.

**Warp.** 1. (*Nautical.*) *a.* A tow-line smaller than a cable.

*b.* A rope or cable used in towing, or in moving a ship by attachment to an anchor or post.

2. (*Weaving.*) The threads running the long way of a fabric. They are wound on the *warp-beam.* The threads of the *warp* are carried up and down by the *heddles* of the harness, forming a track called the *shed*, along which the *shuttle* flies, leaving the *weft, woof*, or *filling*, as it is variously called.

The number of threads in a woolen warp is calculated by *biers* of 40 threads each. Thus an ordinary broadcloth having 3,600 threads in the warp is said to consist of 90 *biers.* The threads would be set in a *sley* or *reed* $3\frac{3}{16}$ yards wide, 2 *ends* or threads passing between every *dent* or *reed* of the *sley.* Fulling will reduce the width of the goods to $1\frac{3}{4}$ yards.

A Venetian cloth having 5,880 threads in the warp would be set in a sley of $1\frac{15}{16}$ yards wide, with 4 ends in a reed; and the cloth, when fulled, would be about 58 inches wide.

The *warp* is known also as the *twist*, or the *chain;* and in silk as *organzine.*

The *weft* is also known as the *woof*, the *shoot*, the *filling;* and in silk as the *tram.*

3. An irrigating process to cover the land with alluvial sediment.

4. The twist of wood in drying.

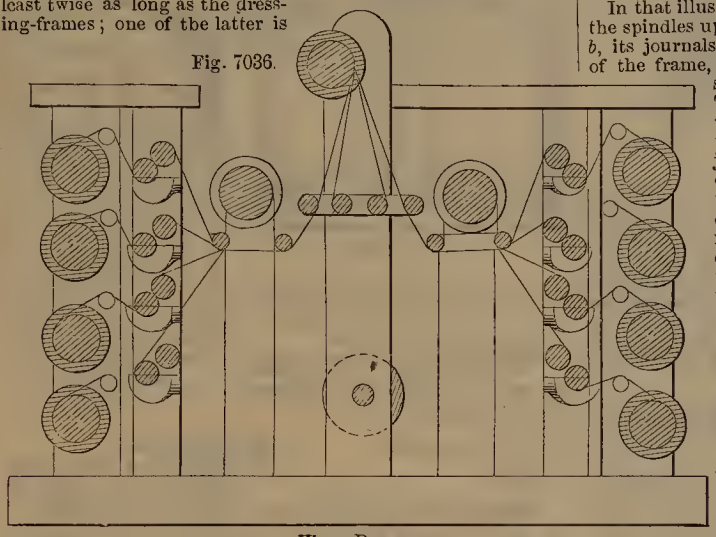
**Warp-beam.** (*Weaving.*) The roller on which the warp is wound, and from which it is payed off as the weaving proceeds. See WARPING-MACHINE.

The woven fabric is wound on to the *cloth-beam.*

**Warp-dress'er.** A machine for sizing yarns for the loom.

In the machine (Fig. 7036), dressing-frames are placed on opposite sides of the center-frame and yarn-beam, which are at least twice as long as the dressing-frames; one of the latter is

Fig. 7036.



*Warp-Dresser.*

placed opposite one half the length of the center-frame, and another opposite the other half. By this means the operator can easily reach to any part of either section of yarn, and a yarn-beam of any length can be filled by employing a sufficient number of dressing-frames, while the tension of all the yarns is nearly equal.

See also Bullough's SLASHER, Fig. 5145, page 2199.

**Warp-dye'ing Ma-chine'.** An apparatus for drawing warp-threads, laid out in sets, through the dye-beck. Each warp is separated from the others by a pin, and is conducted under each lower and over each upper roller in succession until delivered to the squeezing cylinders where the superfluous color is pressed out. Weighted levers regulate the amount of pressure on the upper cylinder.

The whole apparatus stands in the dye-beck.

**Warp'er.** See WARPING-MACHINE.

**Warp-frame,** or **Warp-net Frame.** 1. A lace-making machine which has as many threads as needles, the threads being *warped,* or wound on a beam or roller, the same as in a loom. It differs from the *point-net frame* in this, among other things, that the latter has but a single thread, which is made to form the succession of loops, as in the *stocking-frame.*

2. (*Weaving.*) See WARP-MACHINE.

**Warp'ing-block.** One used in the rigging-loft in warping off yarn.

**Warp'ing-hook.** The brace for twisting yarn in the ropewalk.

**Warp'ing-jack.** The contrivance suspended between the *travers* and the revolving *warp-frame,* and whose duty it is to separate the warp-threads into the *leas* or two alternate sets, one set for each *heald* or *heddle.* Also called the *heck-box.* See WARPING-MACHINE.

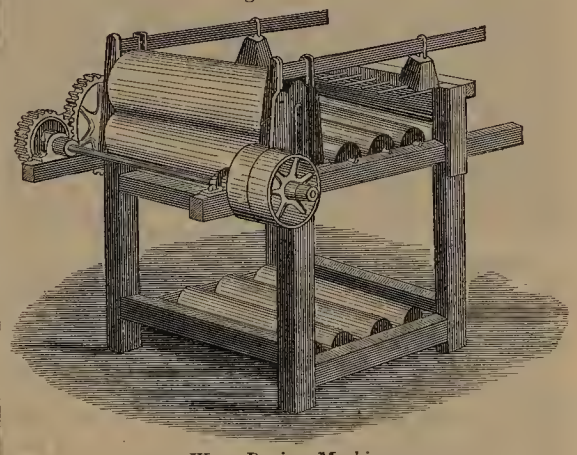
**Warp'ing-ma-chine'.** (*Weaving.*) A machine for *beaming,* that is, laying flat and parallel on the *yarn-beam* the threads of which the warp is composed.

In that illustrated, the yarns, having been first wound from the spindles upon a cylinder *a*, this is transferred to the frame *b*, its journals resting in bearings on the upright standards of the frame, and the mass of warp-threads pressing on the surfaces of two large anti-friction rollers beneath. The yarns divided into sets are passed between the teeth of the separator or *ravel c*, and each thread is separately conducted between two adjacent teeth of a second *ravel d*, and finally secured to the roller or *yarn-beam e*. This rests upon two rollers, caused to rotate in the same direction by gear-wheels engaged by an intermediate pinion on the shaft of the pulley *f*; these carry round the yarn-beam, which withdraws the threads from the roller *a*, winding them upon itself; it is held down and its longitudinal motion prevented by two narrow rollers *g g'*, which bear against a circular projection at each of its ends, and rotate on a common axis journaled in standards upon the pivoted levers *h h'*, which are weighted so that any requisite pressure may be given to the yarn-beam. These contrivances give the minimum amount of friction, equalize the strain, and lessen the danger of rupturing any threads. See also next article.

**Warp'ing-mill.** (*Weaving.*) An apparatus for laying out the threads of a warp and dividing them into two sets.

It comprises a large wooden reel *a* of 12 or more sides mounted on a vertical axis and rotated by an endless band passing around a horizontal wheel at its base, and a second wheel turned by a winch. One sixth of the whole number of threads, on their bobbins, are mounted on a frame *b*, called the *travers,* the bobbins being set loosely upon spindles, so as to

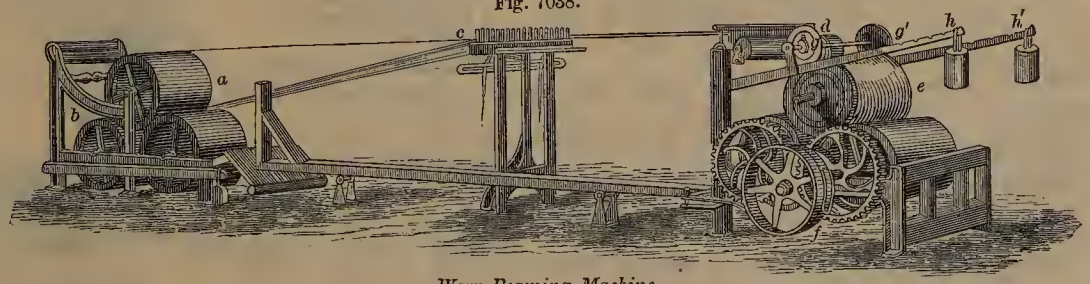
Fig 7037.



*Warp-Dyeing Machine.*

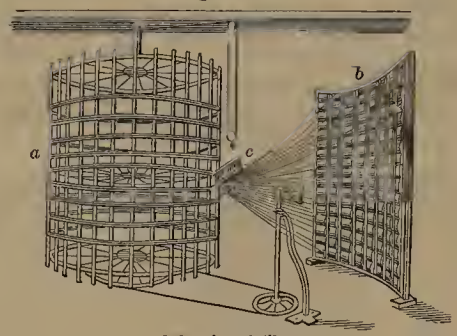
revolve freely. The yarns are passed through the eyes of pins on the *jack* or *heck-box c*, which has a rising and falling motion by reason of its being connected by a cord passing over a pulley to the axis of the mill *a*. The pins in the beck-box are arranged in two sets by each alternate pin being connected to one of two

Fig. 7038.




*Warp-Beaming Machine.*

Fig. 7039.




*Warping-Mill.*

movable bars in the *heck-box*, so that by pushing up one set of pins, after the yarns are passed through, the warp is divided into two *leas*, one for each of the heddles of the loom. The ends of these are knotted together, and they are passed over two pins on the mill, which is then turned by means of the winch. The heck-box rises, and the yarns are wound spirally on the reel; the movement is then reversed, and the box descending by its own weight, a spiral layer is laid on in the opposite direction, and so on until the yarns are all wound off the bobbins. See also previous article.

**Warp-lace.** Lace having a warp which is crossed obliquely by two weft-threads. See also BOBBINET.

The oldest lace has a knit ground, and the ornament worked by the needle. The oldest machine, made in 1764, was a modification of the stocking-frame, and was called the *frame-looped net* machine; six-sided meshes could be made, which held their form when starched, but shrunk like crape when damp.

To this succeeded the *warp-frame*, which had looped stitches, but had so much more solidity that it could be cut and stitched like cloth. In 1810, there were 400 warp-looms at work making Mechlin net.

Heathcote patented his first *twist-net* machine in 1805, and Lord Lyndhurst pronounced it "the most wonderful machine ever invented." It was to make a net like the *bobbin-net* made on the *pillow*. As he observed: "Cushion-made net had half the threads proceeding in wavy lines from end to end of the piece, and may be represented by warp-threads. The other threads, lying between the former, pass from side to side by an oblique course to the right and left, and may be called weft-threads. If the warp-threads could move relatively to the weft-threads so as to effect the twisting and crossing, but without deviating to the right or left hand, and if the weft-threads could be placed so that all of them should effect the twisting at the same time, and one half of them should proceed at each operation to the left and the other half to the right (a substitute being also provided for the cushion-pins), lace would be made exactly as on the cushions." See "Popular Science Monthly," March, 1874, Vol. XLVII., pages 540–542.

**Warp-ma-chine'.** A lace-making machine having a thread for each needle employed; in contradistinction to the stocking-frame, which has but a single thread.

This machine was invented about 1775; it was improved by Dawson in 1784, by the application of the rotary motion and the cam-wheels to move the guide-bars. Warp-machines were the first to produce ornamental patterns on lace, such as spots, bullet-holes, etc.

The Jacquard apparatus was applied to the warp-machine by Draper in 1839.

**Warp-roll'er Reel.** (*Knitting-machine.*) A spool which holds the supply of yarn.

**Wash.** The fermented wort of the distiller. The grain is ground and infused, forming a *mash;* the decanted liquor is a *wort*, which, by fermentation, becomes *wash* for the still.

**Wash-back.** A tun or vat in which *wort* is fermented to form *wash* for distillation.

**Wash-ba'sin.** The *hand-thweale* of the Anglo-Saxons; the *louterion* of the Greeks.

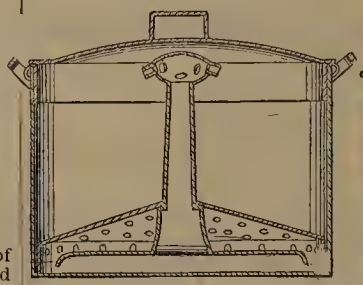
**Wash-bee'tle.** The pounder used in tub-washing; called *battledores* and *batlets* in the sixteenth century.

**Wash'board.** 1. (*Carpentry.*) A skirting around the lower part of the wall of an apartment.

2. (*Nautical.*) A board above the gunwale of a boat to keep the water from washing over.

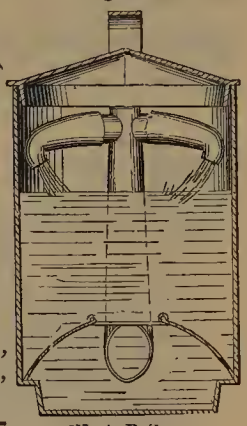
3. (*Domestic.*) A board with a ribbed or fluted surface, over which clothes are rubbed to cleanse them. They are made of wood, of crimped zinc, earthenware, vulcanized rubber, etc.

Fig. 7040.



*Wash-Boiler.*

Fig. 7041.



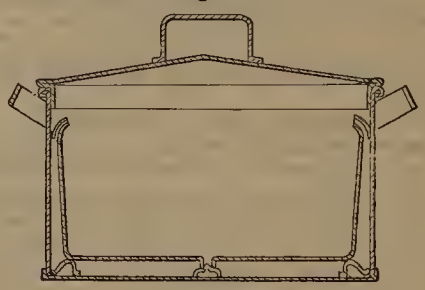
*Wash-Boiler.*

**Wash'board Ma-chin'-er-y.** Includes the following set of tools: —

Dovetailing-machine.
Fluter.
Jointer.
Boring-machine.
Setting-up and nailing machine.

**Wash-boil'er.** A domestic boiler for clothes. It is usually made to stand upon a stove, and ingenuity is shown in various modes of inducing a circulation of water through the clothes, the hot water from below being raised by the generation of steam, and poured in a cascade over the clothes in the boiler. It is a domestic illustration of the keir used in calico-printing works and bleacheries. See BUCKING-KEIR, Fig. 958, page 397.

Fig. 7042.

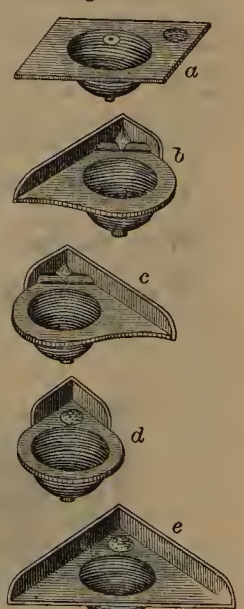


*Wash-Boiler.*

**Wash-bowl.** (*Plumbing.*) Fig. 7043 illustrates various kinds of lavatories or wash-stand tops.

*a*, square-top plug-bowl.
*b*, left-hand corner bowl.
*c*, right-hand corner bowl.
*d*, angle round-bowl.
*e*, angle-bowl.

Fig. 7043.




*Lavatories or Wash-Stand Tops.*

**Wash'er.** 1. (*Machinery.*) An annular disk of metal or wood which slips over a bolt, and upon which the nut is screwed fast.

Washers are also placed beneath bolt-heads; between contacting surfaces which are screwed together, where it forms a packing.

Many locking washers have been invented for preventing nuts from jarring loose. See NUT-LOCK, Fig. 3350, page 1538. See also WALL-WASHER.

Fig. 7044.

*Washer and Lock-Nut.*

Fig. 7044 illustrates a spring-lock for nuts and washers, showing its application to the fish-plate of a rail. Its resiliency permits it to yield to the vibration caused by the passage of the train, keeping the plate in place without disturbing the relation of the nut or washer to the bolt.

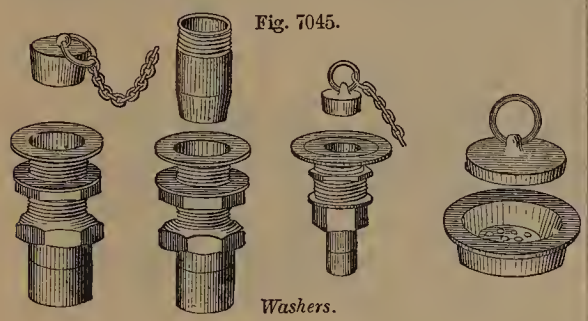
2. (*Paper-making.*) *a.* A *beating-engine* in which rags are washed and coarsely reduced, to bring them to the condition of half-stuff. See STUFF-ENGINE.

*b.* A kind of revolving colander which is formed of wire-gauze, and wallowing in the pulp carries off the dirty water but leaves the pulp.

3. (*Plumbing.*) *a.* The trade term for a bottom outlet in cisterns, etc. The figure shows : —

Ring-plug and washer.
Washer and waste, with *fly-nut* and *union*, for slate cisterns.
Plug and washer.
Basin plug and washer, with fly-nut, union, and chain.

Fig. 7045.

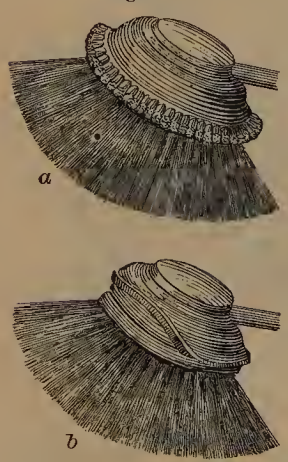


*Washers.*

*b.* A street-washer or pavement-plug, where a hose may be attached to water the street, pavement, or urban garden.

4. The term is also applied to domestic apparatus for cleansing ; as *window*-washer, *dish*-washer, *tumbler*-washer, *vegetable*-washer, etc., etc.

Fig. 7046.

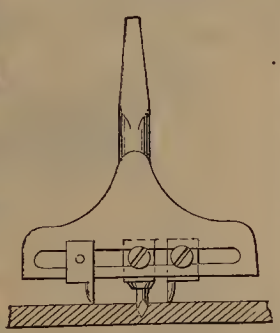



*Leavens's Washer-Brushes.*

*a* (Fig. 7046) is a window-brush, having a projecting row of bristles to keep the wood from breaking the glass.

*b* is a car-washer, having an elastic band which acts as a fender.

Fig. 7047.



*Washer-Cutter.*

5. See also GOLD-WASHER ; and for many other applications of water in sorting ores and saving metals, see list under METALLURGY.

6. A device for precipitating smoke or fumes by a shower of water. See CONDENSER ; SMOKE-CONSUMER, Fig. 5225.

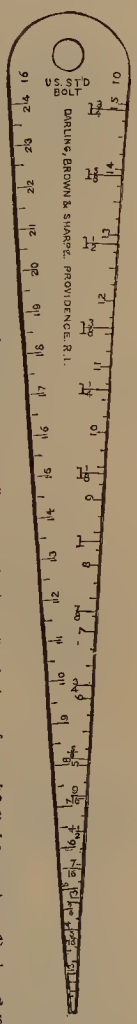
**Wash'er-cut'ter.** A tool for cutting annular disks for washers.

That shown in Fig. 7047 has cutters which may be set out or in the radial slots on each side of the center-pin. The tang of the tool is adapted to be held in the socket of a brace. The cutters are held in any required position by set-screws, and one or both may be used. For washers which are annular, they are set to the sizes of the inner and outer circles required. For wads which are disks, one alone is revolved around the center-pin.

**Wash'er-gage.** An instrument for measuring diameter and thickness, also holes of nuts and washers.

The figures upon one edge are for 16ths and 32ds, and on the other for 10ths and 20ths of inches ; also, United States standard sizes for holes to tap for bolts. Opposite side is graduated the same as a steel rule to 32ds of inches.

Fig. 7048.




*Brown and Sharpe's Nut and Washer Gage.*

**Wash'er-hoop.** A gasket between the flange and curb of a water-wheel.

**Wash-hole.** (*Mining.*) A place where the refuse is thrown.

**Wash'ing-en'gine.** (*Paper-making.*) The first of the rag-engines in which the rags are worked, cleaned, and finally cut when the cylinder is let down upon them. From the washing-engine the *half-stuff* passes to a second engine, called the *beating-engine*. See RAG-ENGINE.

**Wash'ing-ma-chine'.** One for cleaning clothes with water and soap.

The oldest fashions are the rubbing between the hands, the dashing of the clothes on the water, and the pounding of the clothes on stones in the stream.

The modern machines have several other typical forms.

The present state of the art may be said to embrace the following modes : —

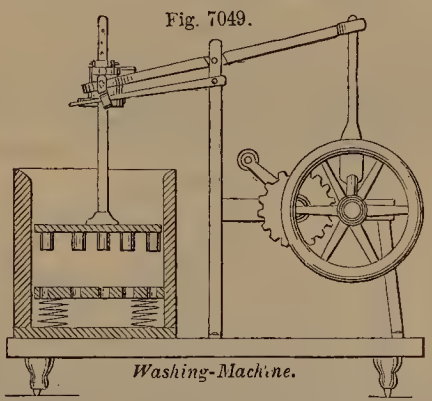
1. *Churning.* The clothes are beaten by a pounder in a tub. In some cases, wooden balls are added to increase the friction.

Fig. 7049 has a combined up-and-down circular motion.

2. The *dash-wheel.* The clothes are put in a barrel which is turned upon an axis, — longitudinal, transverse, or oblique. Such are used in bleacheries. See Fig. 710, page 297.

3. *Sluicing.* The hot water is driven through the clothes. See WASH-BOILER for one form. See also BUCKING-KEIR, Fig. 958, page 397. In Fig. 7050, the clothes are placed in the slat-sided cylinder, and the water circulated by the paddle-wheel at the other end of the suds-box. A stove beneath the metallic bottom gives means of heating. The cylinder and wheel are rotated by a winch upon the paddle-wheel shaft, and a chain connects the shafts.

Fig. 7049.



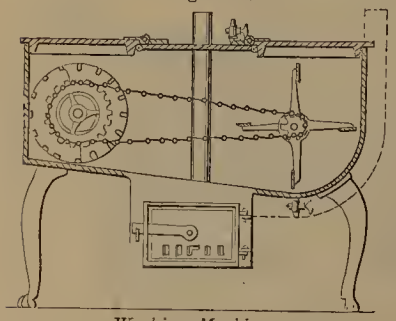
*Washing-Machine.*

4. *Centrifugal.* This is on the principle of the sugar-drainer, and is shown at Fig. 1214, page 514.

5. *Twisting.* The clothes are alternately wetted and then placed in a strong cloth and wrung out.

6. *Squeezing.* In Fig. 7051, the clothes are rolled over and

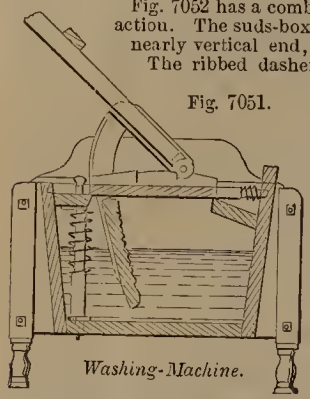
Fig. 7050.



*Washing-Machine.*

over, and squeezed by the segmental arm against a presser-board.

Fig. 7051.



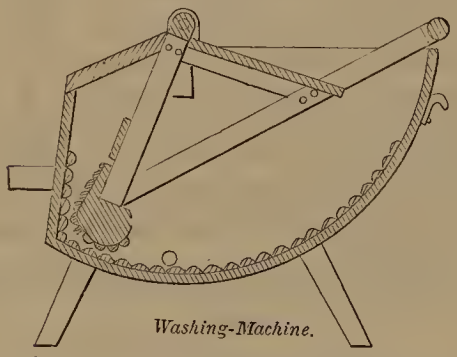
*Washing-Machine.*

Fig. 7052 has a combined squeezing and rubbing action. The suds-box has a curved bottom and a nearly vertical end, armed with transverse ribs. The ribbed dasher is pivoted to a transverse shaft, sweeps over the curved surface, and presses the clothes against the end.

7. *Rolling.* The clothes are carried by an apron between fluted rollers (Fig. 7053).

Fig. 7054 is another form, in which the upper and lower rollers are geared together and turned by a hand-crank. The clothes are passed on an endless apron between the rollers. The operating parts are attached to an inner frame, which is lifted from the tub by a treadle-lever and connecting side-rods. The lower roller is pressed upward against the driving roller by transverse levers connected to its respective ends.

Fig. 7052.

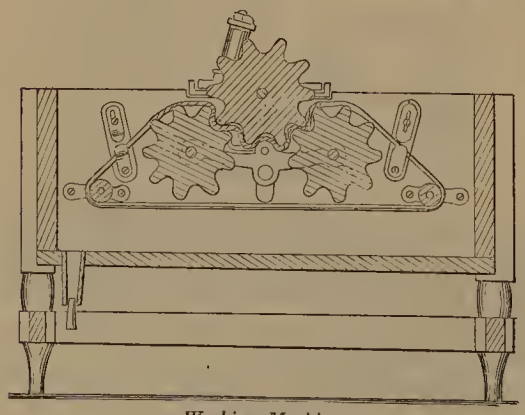


*Washing-Machine.*

8. *Rubbing.* *a.* Between vertical surfaces. The clothes are attached to a gate, which reciprocates vertically between the corrugated surfaces of two spring-pressure bands attached to removable frames in the suds-box (Fig. 7055).

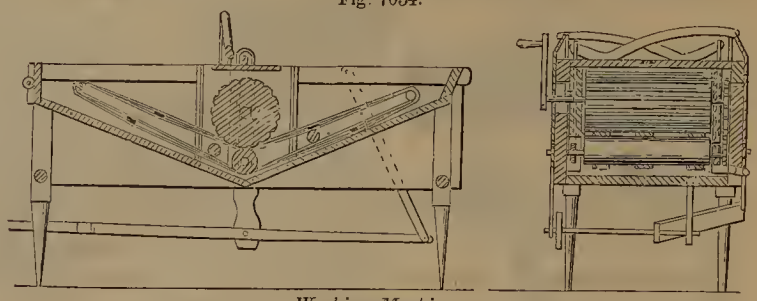
*b.* On a curved bed. A series of concave, corrugated, and

Fig. 7053.



*Washing-Machine.*

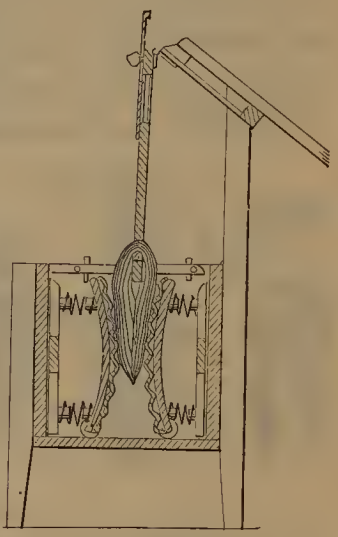
Fig. 7054.



*Washing-Machine.*

yielding fingers, each having a pin encircled by a spiral spring, is hinged by a bolt to the yielding frame, the front edge of which is upheld by spiral springs, its rear edge resting on the tank bottom. Arms and a pin of vibrating rubbers are hung to a frame, and the pressure is adjusted as required (Fig. 7056).

Fig. 7055.



*Washing-Machine.*

*c.* Between flat disks.

In Fig. 7057, the rubber has a circular reciprocating motion, and with its driving mechanism may be vibrated vertically on a hinge to remove the rubber from the tub.

*d.* Between surfaces reciprocating in a direct line. The clothes are thinly spread between two rubbing surfaces, to which latter are given a quick and short alternately reciprocating motion (Fig. 7058).

9. *Rocking.* *a.* On a flat bed (Fig. 7059).

*b.* In a concave (Fig. 7060).

The Oriental "washing-machine" is rather *hard on clothes*, and has caused some surprise to ladies who have sent colored cotton goods *to the wash*, and have received them with all the color beaten out of them. Fig. 7061 illustrates the operation. The clothes are wetted and slapped upon flat stones, then rinsed, and slapped again. It is said to be very effective, but woe to the buttons. One of the ladies of the writer's family had a printed calico dress sent home white by dint of this river-washing in Columbo, Ceylon.

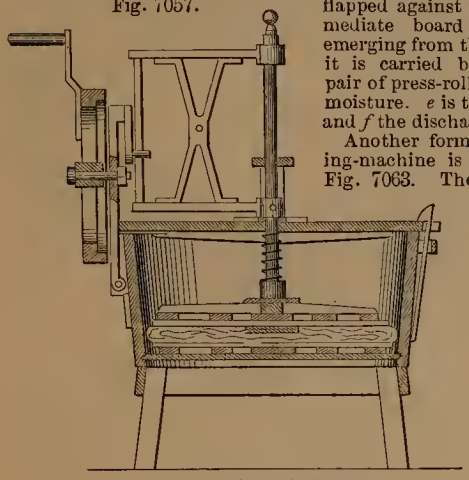
Fig. 7056.

*Washing-Machine.*

The washing-machines of the cotton-cloth manufactories, of bleacheries, dye-shops, etc., are on a somewhat extensive scale, and have specific names, among which may be mentioned *bucking-machines*, *wincing-machines*, *keirs*, *dash-wheels*. Bridson's washing-machine (Fig. 7062) consists of a tank *a* in which are two rollers *b b'* having bars *c c'* placed diametrically to each other. The cloth is conducted by guide-rollers through the water in the

trough in the direction indicated by the arrows, passing eight times around the bars $c\,c'$; as these come in line with each other, the material is flapped against the intermediate board $d$. On emerging from the trough it is carried between a pair of press-rolls to expel moisture. $e$ is the supply and $f$ the discharge-pipe.

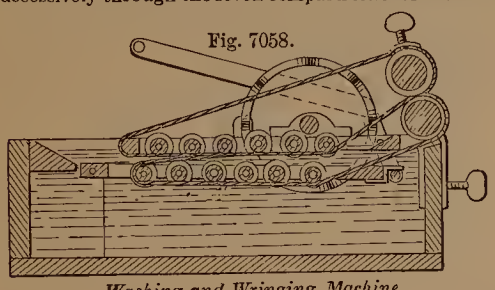
Fig. 7057.



*Washing-Machine.*

Another form of washing-machine is shown in Fig. 7063. The cloth is arranged in folds on a shelf $b$ to the left of the vat $a$, whence it is conducted by rollers through the first compartment, and upward between a pair of rollers which press out the water, and so on successively through the seven compartments of the vat until

Fig. 7058.

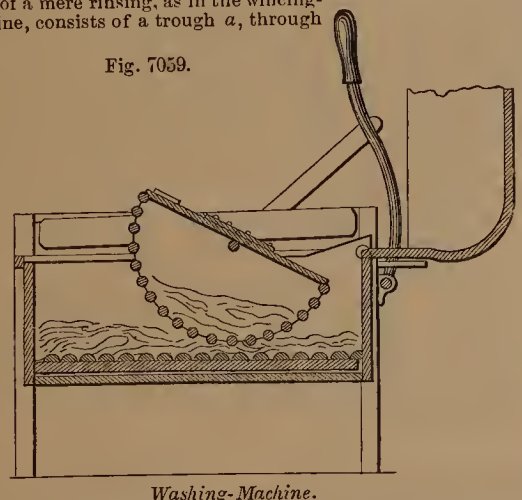


*Washing and Wringing Machine.*

arriving at $c$, where it passes between a pair of rollers kept together by weighted levers, which express most of the moisture. Water is first admitted to the higher right-hand compartment, and flows from that into the next, and so on, causing a current opposite to the direction taken by the cloth.

The dyer's washing-machine, to give a positive washing instead of a mere rinsing, as in the wincing-machine, consists of a trough $a$, through

Fig. 7059.



*Washing-Machine.*

which the folded cloth is carried a number of times in succession as it winds spirally about the roller $b$, being at the same time struck by a series of beaters $c\,c'$ (Figs. 7064, 7065). In all these machines it is customary to tack a number of pieces of the fabric end to end, forming one continuous length.

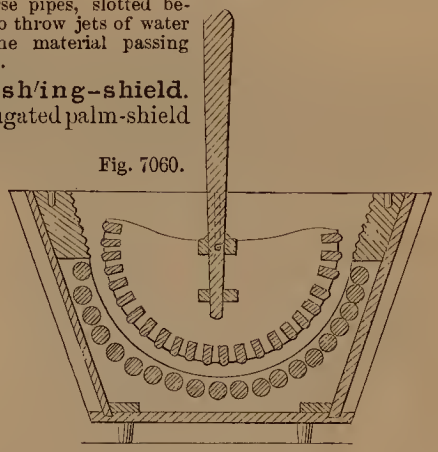
See also Ure's "Dictionary" (American edition), Vol. III. page 257 *et seq.*

Wool-washing machines vary in their construction almost as much as the domestic article.

In Fig. 7066, the wool is passed upon an endless apron between the lower fixed and upper spring rollers, which are all geared together. Above the vacancies between the rollers are transverse pipes, slotted beneath, to throw jets of water upon the material passing through.

**Wash'ing-shield.** A corrugated palm-shield

Fig. 7060.



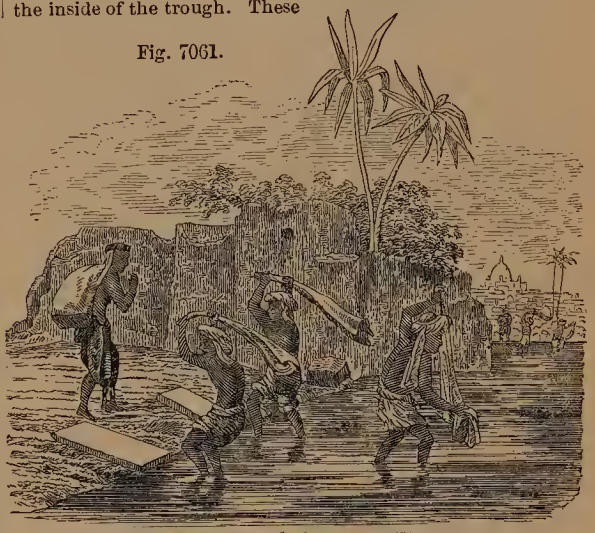
*Washing-Machine.*

or armor to protect the person and form an effective surface for rubbing, or upon which to rub the clothes.

**Washing-ta'ble.** (*Metallurgy.*) A shaking-trough in which ore is sorted by gravity.

Fig. 7068 consists of a long rectangular trough, suspended by hooks, and provided with stops at suitable distances apart on the inside of the trough. These

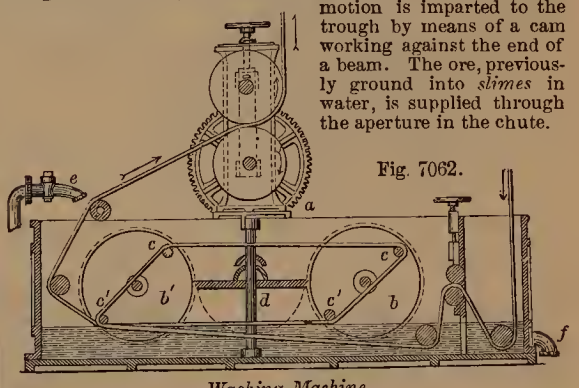
Fig. 7061.



*Indian Dhobees (Washermen), Hindostan.*

stops consist of strips of wood extending from one side of the trough to the other, and kept in place by posts. A vibrating motion is imparted to the trough by means of a cam working against the end of a beam. The ore, previously ground into *slimes* in water, is supplied through the aperture in the chute.

Fig. 7062.




*Washing-Machine.*

**Wash'ing-tub Saw.** An annular saw for sawing tub-staves.

**Wash-leath'er.** Split sheep-skins prepared with oil in the manner of chamois. See CHAMOIS.

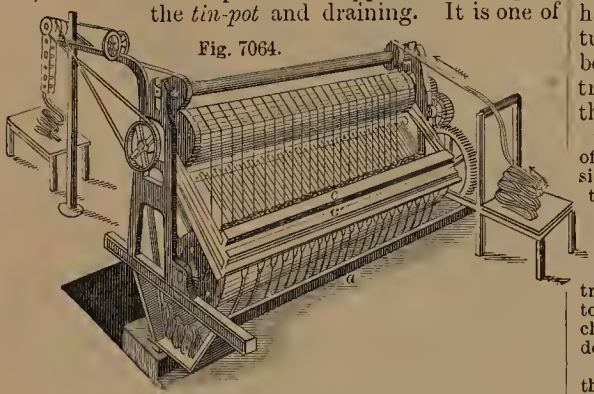
*Alumed*, *tawed*, or *buff* leather.

Fig. 7063.

*Washing-Machine.*

**Wash-pot.** An iron pot containing melted grain tin, into which iron plates are dipped after a dip in the *tin-pot* and draining. It is one of

Fig. 7064.



*Dyer's Washing-Machine (Perspective View).*

the series of five pots and pans used in the manufacture of tin-plate. The *tin-pot*, *wash-pot*, *grease-pot*, *pan*, and *list-pot*. See TIN-PLATE.

**Wash-stand.** A lavatory for the hands and face. See WASH-BOWL.

In Fig. 7069, the reservoir is filled from above and has a cock in the lower side.

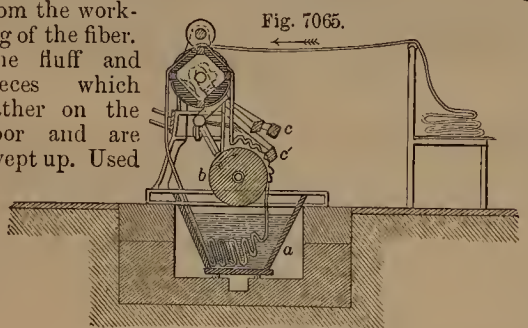
Fig. 7070 is a portable wash-stand.

**Waste.** The refuse of a factory or shop.

1. Broken or spoiled castings which go to the heap to be remelted.

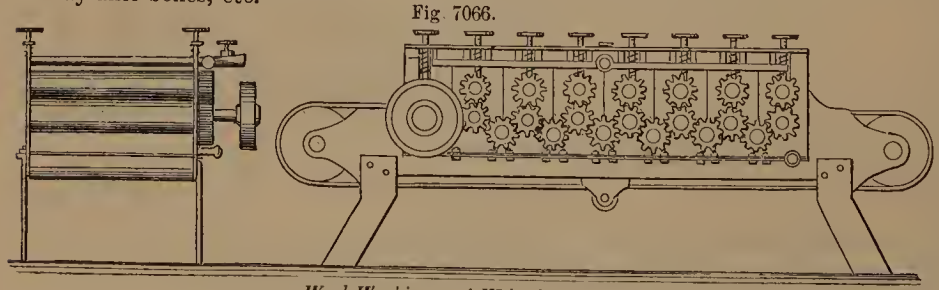
2. The refuse of wool, cotton, or silk, resulting from the working of the fiber. The fluff and pieces which gather on the floor and are swept up. Used as swabs for wiping machinery, as an absorbent in railway axle-boxes, etc.

Fig. 7065.




*Dyer's Washing-Machine (Section).*

Fig. 7066.



*Wool Washing and Wringing Machine.*

3. Paper scraps of an office, printing-house, bindery, etc. Worked over into paper.

4. *Machinist's Waste.* Soiled cotton waste which is too dirty to be longer serviceable for wiping machinery. It is treated to recover the oil.

Fig. 7067.

*Washing-Shield.*

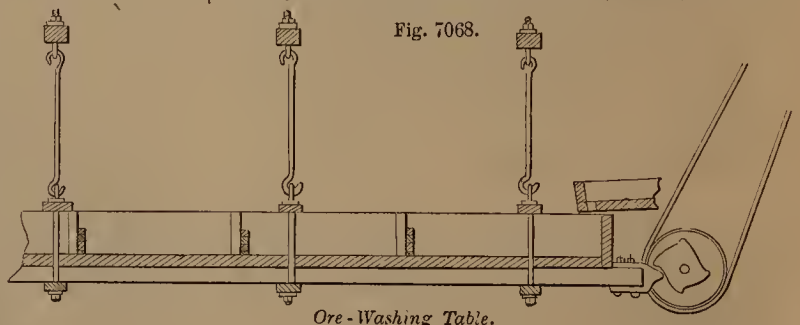
5. *Engineer's Waste.* The cotton stuff which has served its turn in the axle-box, and may be treated to recover the oil.

"The consumption of soap and paper, the quantity of letters exchanged, the extension of public libraries and the use made of them, etc., are often taken as a measure of the actual degree of civilization of a nation.

"An extensive and refined use made of the waste materials of industry and housekeeping might be considered with equal right as the measure of the degree of industrial development and capability. It would also scarcely be possible to find in the trades and in economy of agriculture an instance which shows to the same extent the really creative force of science and the characteristic tendency of a nation to economize so well as its endeavor to keep, like nature, all within the circle of reproduction.

"Side by side with the increase and growth of wants, we see the quantity of useful material augmented in a twofold manner. This is accomplished partly by making use of substances formerly useless, because their qualities were unknown; but still more by the use made of substances which, formerly considered as used up, appeared to be of no value, and were often incommodious and in many cases troublesome.

Fig. 7068.



*Ore-Washing Table.*

"In order to prove only by a few actual cases the assertion last made, that the use of waste materials increases, and that thus difficulties are removed, and that the wealth of the nation at the same time increases, it is only necessary to take, for an example, the quantities of waste materials of soda-factories which were formerly a real nuisance. Nowadays a great part of the sulphur contained in them is extracted, and the remainder, containing chalk and gypsum, is employed as valuable material for agriculture.

"The acid manganese solutions of chloride of lime factories have become restored to use by means of an ingenious chemical process.

"The *scoriæ of metals* produced by blast-furnaces is now used in glass-making, and becomes, by a simple process called *basalting*, a substance useful in the construction of buildings and streets. *Coal and wood tar* play in our time an important part. It is sufficient to call to mind the beautiful *aniline* colors, without speaking of a host of substances which have become useful, like *benzine*, *paraffine*, *creosote*, *carbolic acid*, *pyrocatechin acid*, etc.

"Injurious and even *poisonous gases*, which escape during the process of smelting (*sulphuric acid*, *arsenic*, *zinc* vapors, etc.), have not only been rendered innocuous by contrivances to condense and absorb them, but have even been rendered very useful.

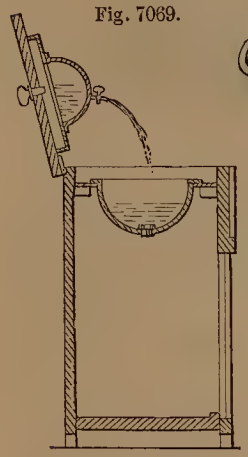
"*Cotton-seed*, which was formerly utterly useless, acquired an increased importance from

the moment when the means of making *oil* from it was discovered. So also with *soap-lees* from laundries, for we now know how to obtain *fat acids* from them.

"Before the International Exhibition of London in the year 1851, the *glycerine* in the factories of *stearine acid* and *candle* manufactures, and the ammonia in *coal-gas* were lost altogether; since then they have both become important objects of manufacture.

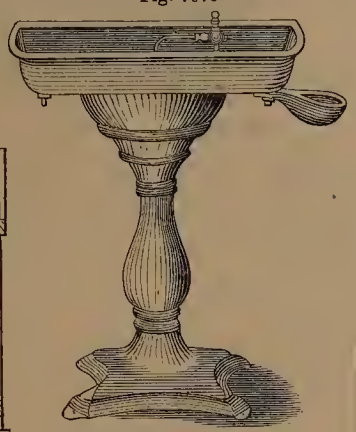
"Woolen *rags*, which were formerly only used for the production of *Prussian blue* and inferior *paper*, but which were for

Fig. 7069.



*Wash-Stand.*

Fig. 7070.



*Portable Wash-Stand.*

the most part thrown on the waste-heap, have now become raw materials, just as well as silk and cotton refuse, for textile industry, and thus render very respectable clothing material accessible even to persons of very moderate means

"The *distillers' wash* produced in molasses-distilleries, and which was formerly thrown away, has become just as useful for the reproduction of *potash* which is obtained from it, and which forms the base of so many valuable alkaline salts; *blood* became useful for the production of *albumine; cork* refuse for the manufacture of *floor-cloths:* old *horseshoe-nails* and other *scrap-iron* for the fabrication of the *soft* and *malleable iron* for English fowling-pieces; and so on, with *sawdust* and *leather refuse*, etc.

"China and Japan mainly owe their flourishing agriculture to the extensive use made of human excrements; and one of the greatest chemists of our time, Baron Liebig, has acknowledged that they contain the means of restoring to the soil of Europe its power of production, a power which will soon be exhausted otherwise" — *Vienna Exhibition Programme*, 1873.

The quantity of anthracite coal-dust which is heaped up in the Pennsylvania coal regions is estimated at 50,000,000 tons. This has heretofore had no commercial value, and indeed it costs 30 cents per ton to dispose of it. Mr. J. E. Wootten, Superintendent of the Philadelphia and Reading Railroad, has succeeded in constructing steam-boiler, locomotive, and puddling furnaces which burn this dust perfectly, and will thus utilize this immense amount of fuel already mined. The furnace consists, in general terms, of perforated grate plates (instead of bars), steam-jet air-blast, and an otherwise hermetically closed ash-pit.

6. (*Hydraulics.*) *a.* A contrivance for allowing the escape of surplus water, as the *waste-weir*, *waste-pit*, or *waste-sluice* of a reservoir.

Fig. 7071.

*Waste.*

*b.* The water so escaping; through a gate, for instance, rather than into the mill-race or penstock.

*c.* Overflow water from a sink or trap.

A pipe for running waste-water from a bath, standing wash-tub, or sink. It is secured by means of jam-nuts *a a* and gaskets to the object. *b* is the plug for bath or basin.

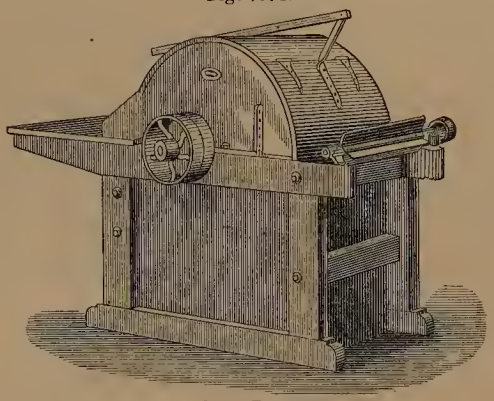
7. (*Mining.*) A vacant space in the *gob* or *goaf*. Old workings.

**Waste-box.** (*Mining.*) A box in which the waste-water is conveyed away from the frames.

**Waste-dust'er.** A machine for cleansing factory waste by subjecting it to the action of rotary beaters, which remove the dust, etc.; these impurities fall through a wire grating, by which the waste is retained.

**Waste-gate.** A gate to allow the passage of surplus water from a pond or canal.

Fig. 7072.



*Waste-Duster.*

**Waste-leaves.** (*Bookbinding.*) Additional blank (or fly) leaves, — usually eight, — bound in with a book next to the covers at the commencement and end of the book proper.

The end *waste-leaves* are pasted to the cover, and in fine work the leaves facing the covers, and their opposites are of marble-paper, to give finish.

**Waste-pick'ing Ma-chine'.** A machine for tearing refuse fabric into shoddy.

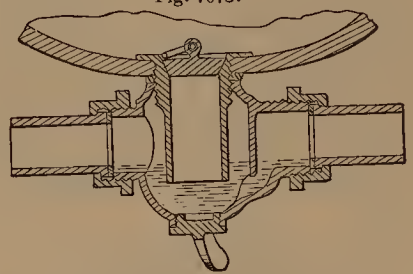
**Waste-pipe.** A discharge-pipe for superfluous water; or of water which has served its purpose.

**Wast'er.** (*Founding.*) The technical term for a casting which is spoiled, and sent to the scrap-heap.

**Waste-steam Pipe.** (*Steam-engine.*) The pipe leading from the safety-valve to the atmosphere.

**Waste-trap.** One for allowing surplus water to escape without permitting air to pass in the other direction. See TRAP.

Fig. 7073.



*Waste-Trap for Wash-Basins.*

**Waste-wa'ter Pipe.** (*Steam-engine.*) The pipe for carrying off the surplus water from the hot-well.

**Waste-weir.** A cut in the side of a canal for carrying off waste-water.

**Watch.** 1. (*Horology.*) A time-keeper actuated by a spring, and capable of being carried on the person. The essential difference between a clock and a watch has been defined to be that the latter will run in any position, but the former in a vertical position only. Since the invention of the cheap spring-clock this definition must be abandoned. Another characteristic which was formerly distinguishing was that the watch escapement was always controlled by a balance-wheel and spring, while the clock escapement was generally governed by a pendulum. There is no law to prevent a person from carrying a small spring-*clock* in his pocket and calling it a *watch*.

The word *watch* is derived from an Anglo-Saxon word, signifying "to wake," and in the sense of a time-keeper first occurs in a record of 1542, which states that Edward VI. "had onne larum or watch of iron, the case being likewise of iron gilt, with two plumettes of lead"; in other words, it was driven by weights. The invention is said to have originated at Nuremberg, 1477; so that watches were formerly playfully called "Nuremberg animated eggs." The invention has also been claimed for Geneva. See also HOROLOGICAL INSTRUMENTS.

For early notices of time-keepers, see CLOCK ; CLEPSYDRA.

The first portable time-indicator was the pocket-dial or the Chinese traveler's companion mounted on the head of a cane, suspended on the breast, or placed on the rail of the wagons in which the Celestials traveled. The Chinese compass is fitted to act as a dial, the points being marked to represent the 24 hours or divisions of a natural day. Of course only a part of these are available, and at the periods of the solstices would be very far from the mark except at noon, but they may have had some system of correction for aught we know. See MARINER'S COMPASS.

Watches are mentioned in an Italian sonnet of 1490, by Gaspar Visconti. Henry VIII. had a watch ; the Emperor Charles V. had several of them ; Shakespeare refers to one in "Twelfth Night" : —

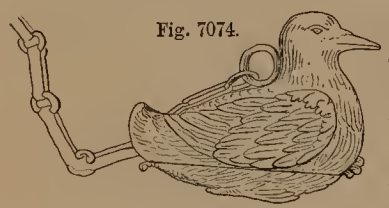
"I frown the while ; and, perchance, wind up my watch or play with some rich jewel." — *Malvolio.*

Also in the answer of the priest to Olivia : —

"Since when, my watch hath told me, towards my grave
I have traveled but two hours."

Fig. 7074 represents a fancy silver watch of the time of Queen Elizabeth. It is shaped like a duck, the feathers chased. The lower part opens, and the dial-plate, also of silver, is encircled with a gilt ornamental design of floriated scrolls and angels' heads. It has an outer case of thin brass, covered with black leather and ornamented with silver studs.

Fig. 7074.



*Watch of the Time of Queen Elizabeth.*

Fig. 7075 is a watch made for Louis XIII. of France to present to King Charles I. It is of silver, richly gilt, the ornaments covered with transparent enamel in white, red, green, blue, and yellow. The back is chased in high relief with the figure of St. George and the Dragon. On the side of the watch is the motto of the order of the Garter. The interior of the case is enriched by a delicately executed arabesque filled with black enamel upon a dotted ground. The entire works take out of the case, being secured thereto by springs, and are all more or less decorated with engraving, the whole interior being chased and gilt.

Fig. 7075.

*Watch made for Charles I.*

In a Swiss museum is an antique watch only $^{3}/_{16}$ inch in diameter, inserted in the top of a pencil-case. The dial indicates not only hours, minutes, and seconds, but also the days of the month.

Fig. 7076 is the *memento mori* watch presented by Mary Queen of Scots to Mary Seaton, her maid of honor, one of the four Marys who waited upon her.

"Yestreen the Queen had four Maries,
The night she 'll hae but three ;
There was Marie Seaton, and Marie Beaton,
And Marie Carmichael, and me"

The watch is of silver, in the form of a skull, and was made by Moyse of Blois.

The watch is opened by placing the skull in the palm of the hand and lifting the hinged lower jaw. The works occupy the place of the "brains," the dial occupying about the position of the palate and to the rear of it. The dial is of silver, fixed in a golden circle, the hours marked in Roman letters. The watch had originally a catgut between the spring-barrel and the train. A bell fills the hollow of the skull, and receives the works within it. A hammer set in motion by a separate escapement sounds the hours. It was evidently intended for a *prie-dieu*, or domestic altar.

Fig. 7076.

*Memento Mori Watch of Mary Queen of Scots.*

Watches stolen from Charles V. and Louis XI. in crowds were discovered by their striking while in possession of thieves. When Guy Fawkes and Percy were detected in the third year of James I. in attempting to

"Blow up the House of Lords,
The king and all his ministers,"

they had a watch "to try conclusions for the long and short burning of the touchwood [fuse] which was prepared to give fire to the train of gunpowder."

"This day was left at my house a very neat silver watch."— PEPYS'S *Diary*, 1665.

The early watches had but one hand, and required winding twice a day. The substitution of a spring for weights was made about 1550. The spring was at first merely a straight piece of steel, not coiled A spring to regulate the balance was first applied by Dr. Hooke, 1658 ; this was at first made straight, but soon improved by making it of spiral form. (See HAIR-SPRING.) This invention has been attributed to Huyghens, but Hooke's priority appears unquestionable. This is the greatest one of all the inventions in the watch, not excepting the compensation balance of Harrison (see page 600). It effected for the watch what the pendulum had done for the clock, and depended upon similar laws. Dr. Hooke showed that the vibrations of such a spring are nearly isochronous, whatever their length, and cause the balance to which they are attached to make its excursions in equal times, although the excursions are longer when the spring is at its greatest power, when just wound up, and less in extent when the spring is nearly run down. The actual difference in the excursions is from nearly a full revolution down to about half a revolution

The repeating-watch was invented by Barlow, 1676 ; Quare invented a repeating movement about the same period. The drilling of jewels for the pivots was first done by Nicolas Facio, a Genevan, in 1700. The order of the jewels for hardness is as follows : diamond, sapphire, ruby, chrysolite, aqua-marine, garnet.

The introduction of the main-spring, with its barrel and fuse, and the hair-spring for regulating its movement, were succeeded by other improvements, which rendered the watch, in its most perfect form, the chronometer, sufficiently accurate to be employed for determining the longitude at sea. Among these were the horizontal escapement of Graham, 1700, and the dead-beat clock escapement of the same inventor, considered to be the original of the lever-escapement for watches. The *detached-lever* escapement may be said to be the product of the labors of Berthoud, LeRoy, Earnshaw, Graham, and Mudge. Harrison, 1735 - 1762, invented the going fusee and the compensation balance for chronometers, finally obtaining the reward offered by the English Board of Longitude for his improvements in time-keepers, which rendered the long-sought solution of the longitude problem practicable. See page 600 ; also specific index HOROLOGY, articles BALANCE ; CLOCK ; CHRONOMETER ; FUSEE ; etc.

For a long period England has maintained a pre-eminence in the quality of her watches, which are, however, expensive. Those of Switzerland do not rank so high, but are cheaper, and are turned out in great quantity, so as to have nearly monopolized the markets of the world. Both classes of these are made entirely by hand, and it was not until 1850 that the plan of employing machinery for the purpose was suggested. This originated with Mr. A. L. Dennison and Edward Howard of Boston, who erected a watch-factory at Roxbury, Mass. ; but the site being found unsuitable, on account of the dust, the establishment was in 1854 removed to Waltham, where it still remains, its products constituting the "Waltham" watches of the "American Watch Company," now so generally and favorably known. The factory is located at Waltham, is on the banks of the Charles River, and is a chain of buildings, roofing nearly two acres, and inclosing a flower-garden. The company's

product amounts to about $1,500,000 per year. It turns out commonly about 350 movements a day, or 105,000 per year, and 4,000 silver cases a month; in the production of which about 900 workpeople are employed, half of them women.

The underlying principle which gives their excellence to these watches consists in the fact that each part is made by a machine specially constructed for the purpose, which imparts to it an accuracy far beyond that attainable by the most skilled hand-labor, nothing being left to the eye or hand of the workman. Every piece is accurately gaged, some of the gages employed being capable of measuring to the $\frac{1}{17000}$ part of an inch. Each piece is thus capable of replacing the corresponding piece in every other watch of the same class, and any number having been assembled to form so many complete watches, from lots taken at random, each watch will be equally perfect, requiring merely to be regulated. Among these parts are screws so minute that it takes nearly 150,000 to weigh a pound. The jewels, with their caps, are also formed by machinery, in a more perfect manner than was formerly done by hand.

One feature claimed as an excellence in these watches consists in dispensing with the fusee, chain, and main-wheel, and their appendages, thus reducing the number of separate parts from 800 to 158, the chain alone being composed of several hundred pieces. This enables the watch to be produced at much less cost, reduces the chances of failure from flaws in the workmanship, and diminishes by one half the friction on the train, enabling thinner and lighter springs to be used, which are more durable and equable in their action. The parts removed, moreover, were the most difficult and expensive to repair. The wide and free motion of the isochronous balance proves quite sufficient to govern and equalize the movement of the train.

After a watch is designed and modeled, and all the special machinery and tools necessary to its reproduction are built, the manufacture of all its several parts begins nearly simultaneously in the several departments. First there is the press-room, where most of the pieces, whether of brass, steel, nickel, silver, or gold, get their crude forms from punches and dies. Next in the frame-rooms all those punched pieces which form what is called the frame or foundation of the watch are completely shaped by turning, milling, or drilling in thousands so precisely alike that they require, when they are put together as single frames, no selection or fitting. These frames are then taken to the engraving department, where they are duly numbered and engraved with their proper trade-marks. Meantime, in the dial department, in the steel-work department, in the wheel and pinion rooms, the balance and escapement rooms, all the other parts of the watch have been started, and are going forward, through a thousand processes, to meet the frame in the jeweling and springing departments, where the movement is assembled and set going for the first time. Nearly the last process is the gilding, after which the watch is finally put together and regulated for sale.

Nearly a thousand processes are used in producing the complete watch, the balance-wheel alone undergoing eighty-four distinct operations.

The watches made are of fifteen general kinds, distinguished by shape and size. These are subdivided into 150 varieties, in which the differences are of finish, number of jewels, construction of the balance and escapement, etc. This is independent of casing.

See also under the following heads: —

| | |
|---|---|
| Alarm-watch. | Repeating-watch. |
| Case-winding watch. | Stem-winding watch. |
| Center-seconds watch. | Stop-watch. |
| Chronometer-watch. | Watch-alarm. |
| Independent-seconds watch. | Watch-glass. |
| Lepine watch. | Watch-key. |
| Lid-winding watch. | Watch-spring. |
| Pendant-winding watch. | |

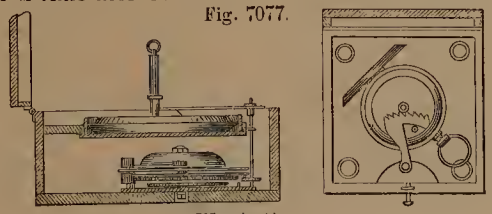
Other watches are distinguished by their escapements. See ESCAPEMENTS. See also HOROLOGICAL INSTRUMENTS.

2. (*Pottery.*) A trial-piece of fire-clay so placed in a pottery-kiln as to be readily withdrawn, to enable the workmen to judge of the heat of the fire and the condition of the ware.

**Watch-a-larm'.** An instrument with going works to sound an alarm at a specified period. It is found in several forms.

*a.* An attachment to a watch, by which the latter operates the alarm-mechanism when the predetermined time arrives.

Fig. 7077.



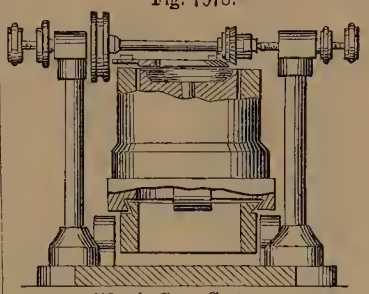
*Watch-Alarm.*

*b.* An instrument with works arranged to trip an alarm after a certain lapse of time, as may be determined.

**Watch-case Cut'ter.** A machine for cutting the hinge-recesses in watch-cases.

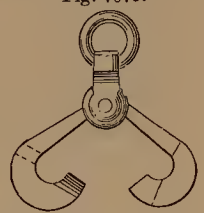
The cover or center is clamped to a block which rests upon a disk that is vertically adjustable in a cylindrical turret upon the carriage, and is brought in contact with the rotary cutter to form the hinge-recess. The block has a concave end to receive the convex side of the cover, and the same or another block has a convex or frusto-conical end to receive the concave side of the cover. The upper side of the cover rests against a removable plate and is clamped thereto by the upward movement of the block.

Fig. 7078.



*Watch-Case Cutter.*

Fig. 7079.



*Watch-Chain Hook.*

**Watch-chain Hook.** A *breguet* or mousing-hook.

In the instance represented, the saddle is united to the mousing-hooks by a joint-pin, and has a swivel-ring for the attachment of the chain-ring.

**Watch-clock.** A clock having electro-magnetic devices for recording by means of a pencil on a paper-dial the time at which a watchman touches a knob, or turns a key at each of a number of stations on his round, each station being connected by a wire with the recording mechanism.

Fig. 7080.

*Watch-Clock.*

The time at which every station was visited, and that occupied in making the entire round, is thus indicated. The paper-dials are changed daily, and the recording instruments for a number of watchmen may be combined in the same case. The clock shown in the illustration is adapted for two watchmen. See also ELECTRO-MAGNETIC WATCH-CLOCK.

**Watch-di'al.** Watch-dials are usually made of thin sheet-copper cut into squares, then into circular disks, and worked to the proper convexity in a concave die by means of a pressing-tool. The necessary holes are then punched and dressed, and a fine glass enamel applied to the exterior side, the inner surface being coated with an inferior sort. This is principally effected with a small spatula. It is then baked in an enameling furnace, and finally the figures and dots for the minutes and seconds are painted on in colored enamel, applied by a camel's-hair brush.

**Watch-glass.** The commonest kind of watch-glasses are simply cut from blown-glass globes and afterward finished by trimming the edge, and more or less perfect smoothing.

The flattened kind are formed from similar globes by first applying a glass of given size to the globe, and striking all around with a red-hot pipe-tube, which breaks out an irregular circle, the angles of which are afterward roughly rounded by means of a dull chisel. 2. These are placed in fire-clay molds of proper size and curvature, and are heated for a few moments

in a muffle to soften the glass, which is then dabbed with a paper pad, causing it to take the form of the mold. 3. The surplus material at the edge is taken off with a wide flat chisel. 4. The glass is stuck with pitch upon a wooden chuck, and the bezel is roughly ground on a grindstone with sand; it is next placed in a lathe, and the bezel finished with pumice-stone. 5. It is smoothed upon a vertical wheel by the action of pumice-powder and water. 6. Polished upon a horizontal wheel with rouge or tin ashes (oxide of tin obtained by calcination) The glasses are finally assorted by gaging into the different sizes known to the trade.

**Watch-jew'el.** A diamond, sapphire, ruby, chrysolite, aqua-marine, or garnet, used for the pivot-hole of a watch to reduce friction and wear. The invention of Nicolas Facio, of Geneva, about 1700.

The list is in the relative order of their hardness. The precious stones are cut into slips by circular saws, and afterward broken into cubes. Then each is turned out in a lathe, fixed in its setting, drilled, and secured in the plate by screws.

In the Waltham Watch Company's works these operations are effected by a beautiful series of machines.

**Watch-key.** An instrument with a socket to fit the *fusee square* or *winding arbor* of a watch, whereby the watch is wound.

The key with a click and ratchet, and which is only effective when turned in the proper direction, is the invention of Breguet of Paris.

**Watch'mak-er's Files.** These files are of various kinds and grades, as to size, degree of taper, coarseness of cut, shape, safe-edged, or otherwise.

Among the varieties specially described under their names alphabetically, are a number adapted to watchmaker's uses; but the following, whose names are derived from their special adaptation or application to particular parts, are not included in the enumeration

Balance-wheel.
Banking.
Barrel-hole.
Clock-pinion.
Clock-slitting.
Endless screw.
Flat dovetail.
French pivot.
Nicking.
Oval dial.
Piercing.
Pivot.
Shouldering.
Swing-wheel.
Verge.
Watch-pinion.
Watch slitting.

See also FILE.

**Watch'mak-er's Glass.** A double convex lens set in a tubular socket, adapted to be held to the eye by the contraction of the orbital muscles.

**Watch'man's A-larm'.** In the olden time the watchmen were provided with rattles, consisting of a ratchet-wheel and a spring tongue, which clicked loudly as it snapped

Fig. 7081.

*Watchmaker's Glass.*

Fig. 7082.

*Watchman's Alarm.*

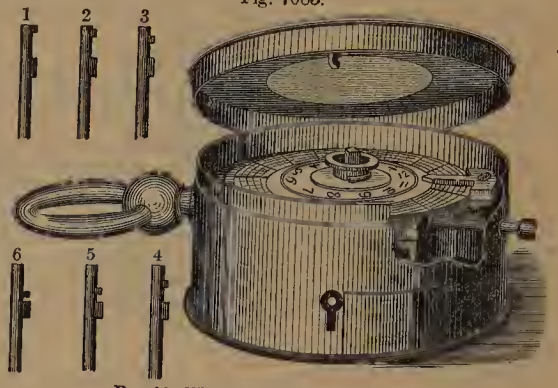
on each tooth as the rattle was revolved upon the axis of the ratchet.

Modern times have developed other means of sounding an alarm, such as striking upon the pavement with a club, blowing a whistle, exploding a torpedo, or firing a pistol.

**Watch'man's Time-de-tect'or.** Fig. 7083 shows an instrument carried by a watchman who visits the various places on his beat where the keys are within reach. Six keys are shown for as many watchmen, and when inserted in the watch will prick a hole at a point opposite to the hour at which the visit is made, and each man's record in his own row. See also Fig. 7080.

The clock (Fig 7084) has a small central slate-edged dial over the main dial, and its face is protected by a plate of glass having a perforation large enough to admit a pencil, by which a mark may be made on the small dial; this is connected with and carried around by the hour-hand, so that the time at which each mark is made is shown; and if the watchman omits to perform this duty at the proper time, the absence of the corresponding mark shows the fact. The marks are readily wiped off from the slate. Paper dials, which may be filed away as records,

Fig. 7083.

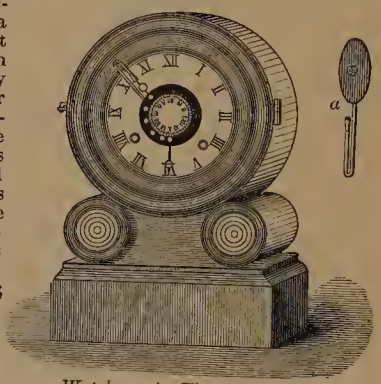



*Buerk's Watchman's Time-Detector.*

can also be used. *a* is a reverse view of the sub-dial, showing its means of connection with the clock.

The time-indicator used on the French railways (1853) is the invention of M. Aresa. It is also used in other public establishments guarded by police or watchmen.

Fig. 7084.

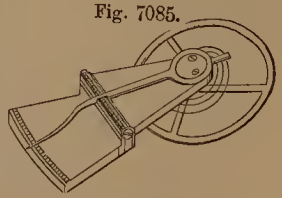



*Watchman's Time-Detector.*

A sort of table-clock is placed at a particular spot, at which the watchman must be at every quarter of an hour during his night-patrol; at that time he is required to press his finger on a stud or button, which is the only part of the apparatus at his command. Beyond this he knows or does nothing in the matter; but when the clock-case is opened next day by a superintendent, a circular graduated card is found to be pierced with as many small holes as the guard had made pressures on the stud; and the card also shows the exact hour and minute when each hole was pierced. The mechanism is very simple; the circular card or paper is made to rotate by connection with the hour-wheel of the clock, and the button or stud acts upon a sharp needle, which pierces the card. If the card is not pierced opposite to a particular quarter of an hour, the conclusion is drawn that the guard has failed in vigilance.

**Watch-reg'u-lat'or.** (*Horology.*) A lever for regulating the effective length of the balance-spring, in order to affect the pulsations of the latter, and so of the rate of going of the watch.

Fig. 7085.



*Watch-Regulator.*

In Fig. 7085, by turning the screw, delicate adjustment is given to the arm of the regulator, whose outer end has a finger resting on the graduated scale.

**Watch'-spring.** The steel spring which drives the watch-movement.

Watch-springs are hammered or rolled out of round steel wire, of suitable diameter, until they fill the gage for width, which at the same time insures equality of thickness; the holes are punched in their extremities and they are trimmed on the edge with a smooth file. The springs are then tied up with the binding-wire in a smooth coil, and heated over a charcoal fire on a perforated revolving plate; they are then hardened in oil and *blazed off*. This latter term refers to the inflammation of the grease when they are held over a fire after being hardened. See TEMPERING.

The spring is now distended in a long metallic frame, similar to that used for a saw-blade, and ground and polished with emery and oil, between leaden blocks. Its elasticity is restored by a subsequent hammering on a very bright anvil, which *puts the nature into the spring*.

The coloring is done over a flat plate of iron, or hood, under which a little spirit-lamp is kept burning; the spring is continually drawn backward and forward, about two or three inches at a time, until it assumes the orange or deep blue tint

throughout, according to the taste of the purchaser; by many the coloring is considered to be a matter of ornament, and not essential. The first process is to coil the spring into the spiral form, that it may enter the barrel in which it is to be contained; this is doue by a tool with a small axis and winch-handle, and does not require heat.

The balance-springs of marine chronometers, which are in the form of a screw, are wound iuto the square thread of a screw of the appropriate diameter and coarseness; the two ends of the spring are retained by side-screws, and the whole is carefully enveloped in platinum-foil, and tightly bound with wire. The mass is next heated in a piece of gun-barrel closed at the one end, and plunged into oil, which hardens the spring almost without discoloring it, owing to the exclusion of the air by the close platinum covering, which is now removed, and the spring is *let down to the blue*, before removal from the screwed block.

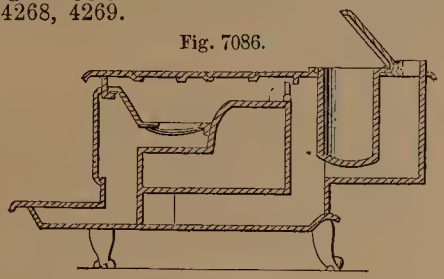
In hardening them, they are heated by being drawn backward and forward through an ordinary forge fire, built hollow, and they are then immersed in a trough of plain water. In tempering them, they are heated until the black red is just visible at night; by daylight the heat is denoted by its making a piece of wood sparkle wheu rubbed on the spring, which is then allowed to cool in the air.

**Watch-tack'le.** (*Nautical.*) A luff-tackle with a *tail* double-block and a hook single-block. See TAIL-TACKLE.

**Wa'ter-an'chor.** A *drag-anchor*. A sail spread on spars and thrown overboard to keep a vessel's head to the wind, or to prevent her drifting so fast. See DRAG-ANCHOR, Fig. 1738, page 737.

**Wa'ter-back.** A permanent reservoir at the back of a stove or range, to utilize the heat of the fire in keeping a supply of hot water. See also RESERVOIR, Figs. 4268, 4269.

Fig. 7086.

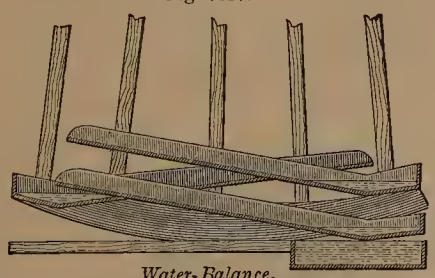


*Stove Water-Back.*

**Wa'ter-bal'ance.** An oscillating, pendulous frame, having a series of troughs in vertical series and inclined in alternate directions, so that, as the frame oscillates, the water dipped by the lower one shall be poured into the next above, which, on the return motion, shall pour it into the next, and so on.

It is an old contrivance, and is susceptible of a variety of modifications, which are cited in some of the older works on hydraulics.

Fig. 7087.



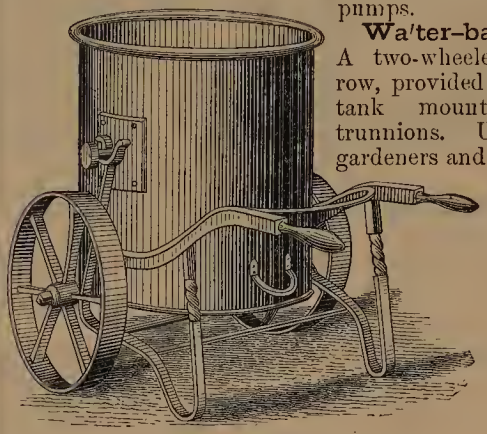
*Water-Balance.*

**Wa'ter-ba-rom'e-ter.** One in which water is employed instead of mercury for indicating the fluctuations in atmospheric density.

An instrument of this kind was constructed in 1832 by Professor Daniell in the hall of the Royal Society; the glass tube, in one piece, was 40 feet long, and about an inch in diameter. Originally, the water in the cistern was covered with a layer of castor oil, but this was found not to prevent the access of the exterior air; it became necessary to refill the tube in 1845, when a solution of caoutchouc in naphtha was substituted for the oil. The average hight of the column of water in the tube was 400 inches, and its sensibility was much greater than that of mercury, so that iu windy weather it appeared to be in a state of perpetual fluctuation. Its indications also preceded by an hour those of the mercurial barometer of ½-inch bore, which precedes by a similar interval the mouutain-barometer of 0.15-inch bore.

**Wa'ter-bar'rel.** (*Mining.*) A large wrought-iron barrel with a self-acting valve in the bottom, used in drawing water where there are no pumps.

Fig. 7088.



*Water-Barrow.*

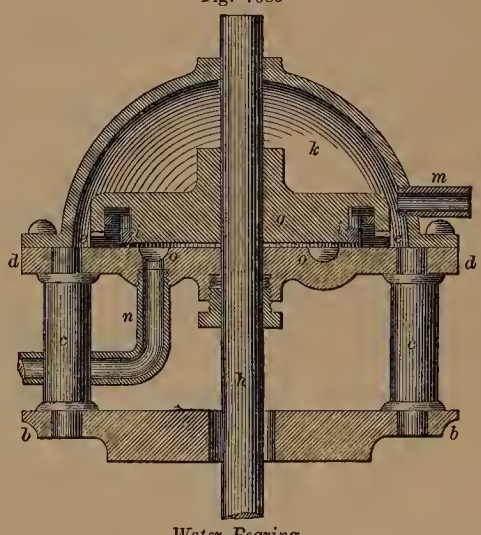
**Wa'ter-bar'row.** A two-wheeled barrow, provided with a tank mounted on trunnions. Used by gardeners and others.

**Wa'ter-bath.** A means of heating an object by application of hot water to the vessel containing it. See Chambers's "Encyclopedia," Fig. on page 398, Vol. VII.

**Wa'ter-bear'ing.** A device in which water or steam pressure is employed to counterbalance the downward pressure upon a rotating shaft, thereby obviating friction.

In Shaw's (Fig. 7089), water from a pump, or steam, is admitted through a pipe *n* communicating with an annular groove *o* in the plate *d*, supported by pillars *c c* resting on the bed-plate *b*. To the rotary shaft *h* is attached the disk *g*, having a circular groove near its edge for receiving the annular piston *e*, which bears upon the upper face of the plate *d* until the pressure

Fig. 7089.




*Water-Bearing.*

exceeds a certain regulated amount; when this is exceeded, the disk *g* rises until the ring *i* surrounding the disk touches the upper inwardly projecting part of the piston, lifting it clear of the plate, and allowing the fluid to escape into the dome-shaped chamber *k*, whence it is drawn off by the pipe *m*.

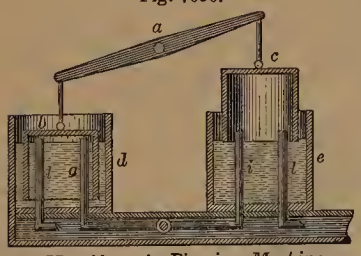
See also PALIER GLISSANT, Fig. 3496: HYDRAULIC PIVOT. Described in Bramah's English patent, 1802.

**Wa'ter-bel'lows.** A form of blowing-machine invented by Hornblower.

It consists of two or more inverted vessels *b c* suspended from the ends of a working-beam *a*, and alternately rising and falling in the cisterns *d e*, which are nearly full of water. Induction

and eduction pipes pass from below upward into the cisterns, their upper open ends being above the level of the water. *h* is the eduction-pipe, with branches *g i* to the air-spaces beneath the inverted vessels. *l* are the eduction-pipes leading to a common trunk, by which the air is discharged. The induction-pipes *g i* have valves on top, and the eduction-pipes *l* have valves at the bottom, so that the air cannot pass in the wrong direction.

Fig. 7090.




*Hornblower's Blowing-Machine.*

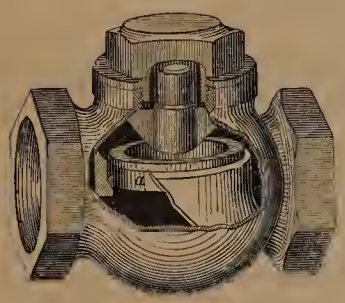
The action is as follows: —

As the vessel *c* rises, air passes by the induction-pipe *i* to the space in the said vessel, the vessel *b* at the same time descending and driving the air contained therein by means of the eduction-pipe *l* to the exit. When the working-beam *a* oscillates in the other direction, the vessel *c* becomes the induction and *b* the discharging vessel.

This is a common form of water-bellows in air and gas carbureting machines.

**Wa'ter-bosh.** A metallic basin in a puddling or boiling furnace, which is made double, so that water may circulate therethrough to protect the furnace from the destructive action of heat and cinder.

Fig. 7091.



*Water-Check Valve.*

**Wa'ter-bridge.** (*Steam.*) A low vertical partition at the back of a furnace to deflect the flame upward. The bridge is hollow and connected with the water-space of the boiler, of which it forms a part.

**Wa'ter-car'ri-er.** A form of water-elevator in which the bucket lifted from the well or cistern is transported on wires to the house at a considerable distance.

**Wa'ter-check.** A check-valve, belonging to the Gilfard injector, to regulate the supply of water. See Fig. 7091, and Fig. 123, page 56.

**Wa'ter-check Valve.** (*Steam-engine.*) An automatic valve for controlling the supply of water delivered to the boiler by the feed-water pipe. See CHECK-VALVE.

In the example, a portion of the liquid is always inclosed in the annular space surrounding the disk *a*, which in falling to its seat is prevented from coming immediately in contact with the metal, the water acting as a cushion. The disk and seat therefore are not distorted by hammering, and the valve is almost noiseless in its action.

**Wa'ter-clock.** An instrument to indicate the time by the passage of water into or from a vessel. See CLEPSYDRA.

A more modern form of water-clock was invented in the seventeenth century, probably by an Italian ecclesiastic at Bologna; or by a pewterer at Sens, in Burgundy.

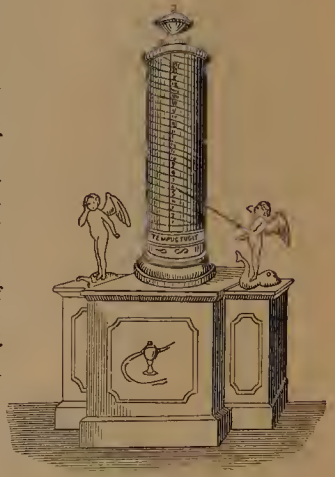
It consists of a cylinder divided into several small cells, and suspended by a thread fixed to its axis, in a frame on which the hour distances, found by trial, are marked out. As the water flows from one cell into the other, it changes very slowly the center of gravity of the cylinder and puts it in motion, much like the quicksilver puppets invented by the Chinese.

Beckmann refers to an alarm-apparatus attached to one of these clocks "which consists of a bell and small wheels, like those of a clock that strikes the hours, screwed to the top of the frame on which the cylinder is suspended. The axis of the cylinder, at the hour when one is desirous of being wakened, pushes down a small crank, which, by letting fall a weight, puts the alarum in motion. A dial-plate with a handle is also placed, sometimes, over the frame."

An instrument of the kind presented by Haroun al Raschid to the Emperor Charlemagne had a striking-apparatus. When the 12 hours were completed, 12 doors opened on its face, and from each rode forth an automaton horseman, who waited until the striking was over, and then rode back again, closing the door behind him.

Fig. 7092 illustrates one in which the descent of the water and its accumulation in the reservoir forming the base cause the two figures with wings to rise, the one with the wand pointing out the hours.

Fig. 7092.



*Water-Clock.*

"The clepsydra is still used on board the *praus* of the Malayan Archipelago. It is a bucket half filled with water, in which floats the half of a well-scraped cocoa-nut shell. In the bottom of this is a small hole, so that a small jet rises in the shell, which is gradually filled thereby, and so nicely is the size of the hole graduated to the capacity of the shell, that it sinks exactly at the end of an hour. The man on watch then cries out the number of hours from sunrise, and sets the shell afloat again empty." — WALLACE'S *Malayan Archipelago.*

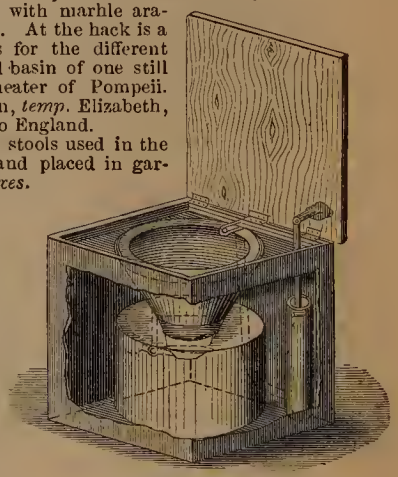
**Wa'ter-clos'et.** A commode with water-supply to empty the basin and carry off the contents.

The water-closet, in its essential features, was invented by Bramah. These features may be described as a pan, a discharging valve, and a water-cock which comes into action as the discharge-valve is opened.

The water-closet of the palace of the Cæsars was adorned with marble arabesques and mosaics. At the back is a cistern with faucets for the different seats. The pipe and basin of one still remain near the theater of Pompeii. Sir John Harrington, *temp.* Elizabeth, introduced them into England.

The portable close stools used in the reign of Elizabeth, and placed in garrets, were called *ajaxes*.

Fig. 7093.



*Portable Water-Closet.*

Fig. 7093 is a portable, self-acting water-closet.

In that shown in Fig. 7094, depressing the seat pushes down a rod connected to a weighted lever, which opens the water-pipe valve, and also to the end of a second weighted lever, which opens the valve at the bottom of the pan. On the removal of the pressure, the weighted levers automatically close the valves.

In one form of closet there is a jet for the purpose of applying a douche in cases of hemorrhoids.

Fig. 7094.

*Water-Closet.*

In the Carr closet (Fig. 7095), the valve-pull operates through a series of jointed levers having a certain amount of lateral play, so that freedom of action is insured if the parts are slightly out of

their proper adjustment. By removing the front piece of the container, the pan may be removed and replaced, and the trap of the closet cleared, if foul, without interfering with the other parts or shutting off the water-supply.

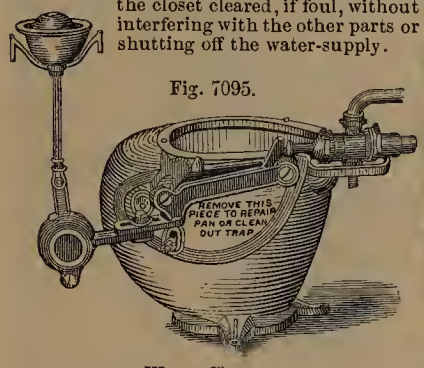



Fig. 7095.

*Water-Closet.*

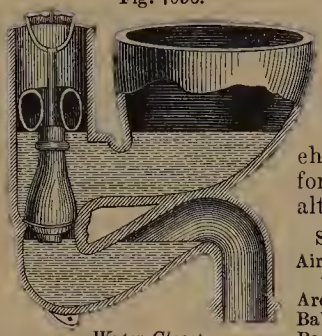


Fig. 7096.

*Water-Closet.*

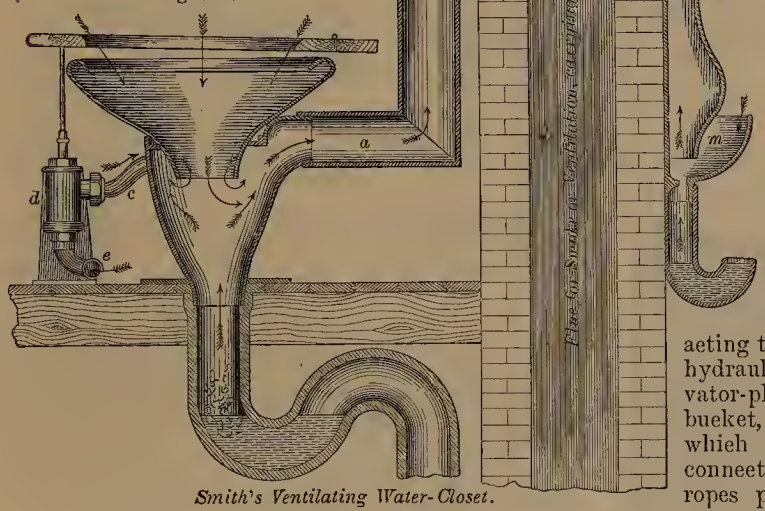
Fig. 7096 is the Jennings water-closet.

Fig. 7097 illustrates R. D. O. Smith's ventilating water-closet. It is provided with a pipe *a* leading into a ventilating pipe or flue *b* for carrying off the foul air. A descending current is produced in the pan by the suction of the flue or by the influx of water from the pipe *c*, of which *d* is the valve and *e* the delivery-pipe. *m* is a urinal in another apartment, with a similar upcast draft to remove fetid air.

### Wa'ter-clos'et Ba'sin.

Fig. 7098 is a purifying water-closet basin, the receptacle holding a cake of disinfecting soap, over which the water flows in entering the bowl.

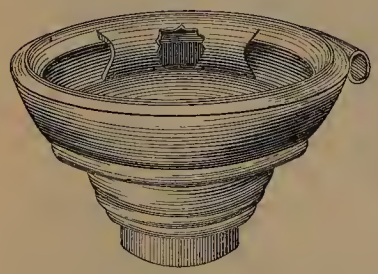
Fig. 7097.




*Smith's Ventilating Water-Closet.*

**Wa'ter-clos'et Valve.** One adapted to be brought into operation by the handle, and also limit the amount of water supplied to empty and cleanse the pan.

Fig. 7098.



*Purifying Water-Closet Basin.*

**Wa'ter-cool'er.** One in which water and ice are cased with a non-conducting material to prevent access of heat. See pages 1169, 1170.

**Wa'ter-core.** 1. A body of water occupying a hermetically closed axial cavity in a car-axle, for the purpose of conducting away heat from the journals. See patent No. 136,791. 2. A hollow core containing flowing water used in some modes of casting.

**Wa'ter-crane.** A goose-neck apparatus for supplying water from an elevated tank to the tender of a locomotive-engine. See TANK.

**Wa'tered Goods.** See WATERING; MOIRE.

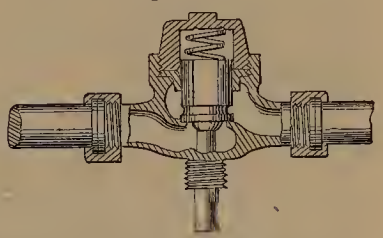
**Wa'ter-el'e-va'tor.** 1. A device for raising buckets in wells.

The forms are various; the special arrangements being for tipping, discharging, and returning the buckets; for acting upon counterbalancing buckets alternately, etc.

See under the following heads: —

| | |
|---|---|
| Air as a water-elevator. | Persian wheel. |
| Archimedean screw. | Picotah. |
| Baling-machine. | Pot-wheel. |
| Bascule. | Pump (varieties; see PUMP). |
| Bucket-wheel. | Ram. Hydraulic |
| Cane. Hydraulic | Scoop. |
| Chapelet. | Scoop-wheel. |
| Driven well. | Screw. Archimedean |
| Dutch-scoop. | Shadûf. |
| Ejector. | Steam water-elevator. |
| Flash-wheel. | Sweep. |
| Flush-wheel. | Turbine. |
| Horn-drum. | Tympanum. |
| Hydraulic belt. | Water-appliances (see list under HYDRAULIC ENGINEERING, etc.). |
| Hydraulic cane. | Water-balance. |
| Hydraulic ram. | Water-carrier. |
| Jantee. | Water-screw. |
| Mental. | Well-bucket elevator. |
| Monte-jus. | |
| Noria. | |

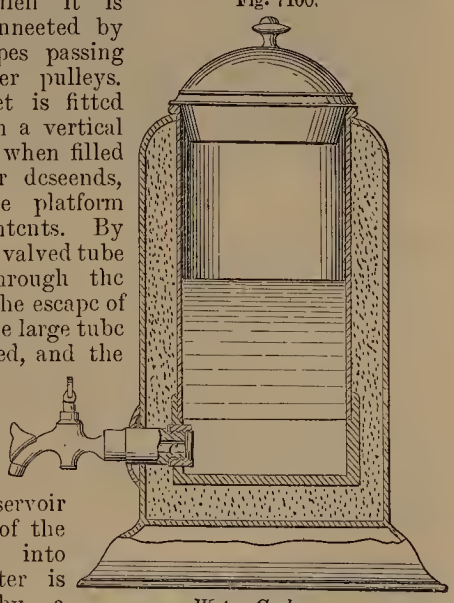
Fig. 7099.



*Water-Closet Valve.*

2. An elevator for warehouses and other buildings, operated by water acting through the medium of gravity or by hydraulic pressure. In one form, the elevator-platform is balanced by a large iron bucket, with which it is connected by ropes passing over pulleys. The bucket is fitted air-tight in a vertical shaft, and when filled with water descends, raising the platform and its contents. By means of a valved tube passing through the platform, the escape of air from the large tube is controlled, and the rapidity of descent regulated. The bucket is filled from a reservoir at the top of the building, into which water is pumped by a

Fig. 7100.

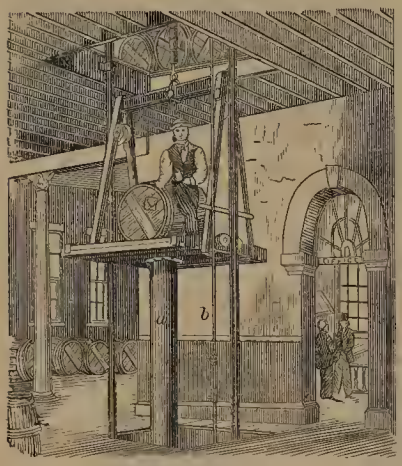


*Water-Cooler.*

steam-engine. See HYDRAULIC ELEVATOR; ROPE-ELEVATOR; etc.

In Fig. 7101, the pillar *a* on which the platform is sustained is the ram of a hydraulic press, the cistern of which is located beneath the floor of the lowest story from which the goods are to be elevated. The rod *b* is employed for operating a cock, by which the water is admitted to or shut off from the cylinder to raise or to suspend the platform.

Fig. 7101.



*Water-Elevator.*

On forcing water into the cistern in which the ram *a* works, it, with the platform, is caused to rise, and is lowered by opening a cock, which allows the water to escape and the apparatus to descend by its own gravity, at a rate proportioned to the size of the efflux openiug.

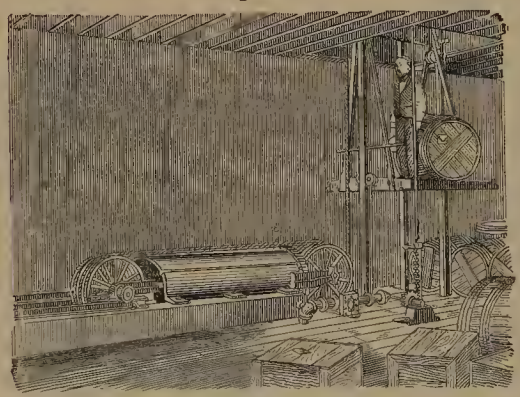
Fig. 7102 is another form, in which a ram in a water-cylinder actuates a set of sheaves, and works a rope from which the cage is suspeuded. See ROPE-ELEVATOR.

**Wa'ter-en'gine.** 1. Onc driven by water, as a WATER-WHEEL (which see, for a list of varictics).

2. The term is somewhat more dcfinitely applied to an engine in which water under pressure of a head acts upon a piston. See HYDRAULIC ENGINE; WATER-MOTOR.

Engines of this kind are employed in some mines on the Coutinent of Europe. They are either double or single acting. In the first class, the motion of a descending column of water entering below the pistou of a suitable cylinder with open top is

Fig. 7102.



*Hydraulic Elevator.*

caused to lift the piston, which, when the water is withrawn, descends by atmospheric pressure. The alternate induction and eduction are automatically effected by appropriate valve counections through pipes at the bottom of the cylinder.

In the double-acting water-engine (Fig. 7103), the cylinder *a* is closed at both ends, and has a vertical supply-pipe *b*, communicating with the cylinder through the two horizontal pipes *c c'*, each of which alternately serves for induction and eduction. The pistons *d d'* are on the same rod with the piston *e* contained in a cylinder *f* above and separated from that which contains the two lower pistons. A lever *g* attached to the piston-rod of the main cylinder *a* is connected with a four-way cock *h*, which is, by the back-and-forth movement of the said piston-rod, caused to admit water through the pipes *i i* alternately above and below the piston *e*, which thus throws the pistons *d d* into such position as that each of the openings *k k'* by turns receives water from the pipes *c c'* and communicates with the discharge-pipe *l*. The small pipe *m* serves as the eduction for the cylinder *f*.

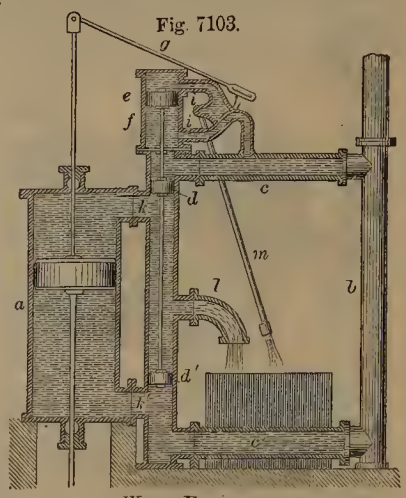
See also WATER-ELEVATOR; and list under HYDRAULIC ENGINEERING.

**Wa'ter-float.** A device in a cistern, boiler, etc., which, floating on the water, actuates a valve. See WATER-GAGE.

Fig. 7104 has a stone which is so far counterbalanced by the suspended ball as to float ou the water and actuate a valve when the water is too high or too low in the steam-boiler.

**Wa'ter-frame.** A namc conferred upon the spinning-machine invented by Arkwright, and patentcd 1769.

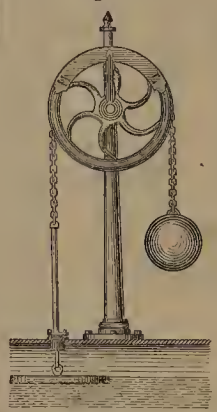
Fig. 7103.




*Water-Engine.*

The term *frame* was commonly applied in the midland counties of England, where the cotton, wool, and flax manufactures most abounded, to a mechanical structure in a wooden framework. Such were the *silk-frame*, *stocking-frame*, and *lace-frame*.

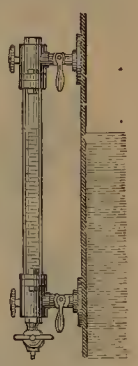
Fig. 7104.



*Water-Float.*

The *water-frame* was so named because its enterprising inventor, who first brought together the various machines for working on cotton, organizing them into a mill, employed water as the motor. See THROSTLE.

Fig. 7105.



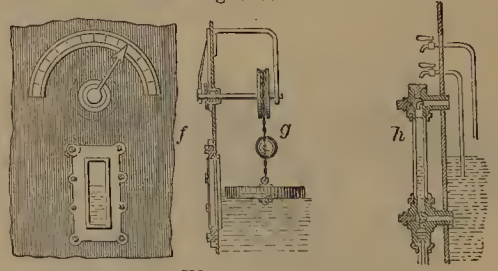
*Water-Gage.*

**Wa'ter-gage.** (*Steam-engine.*) An instrument or attachment to a steam-boilcr to indicate the dcpth of water thercin.

The ordinary form of a water-gage is a strong glass tube placed in a vertical position outside the boiler, and commnnicating at top and bottom by metallic tubes with the iuterior of the boiler. The tubes are provided with stop-cocks, by which access of steam or water is cut off when desired. The water enters at the lower end, and steam at the upper end, the water-level in the tube coincides with that in the boiler.

Another *water-gage* takes the form of a *float* iu the boiler, and a protruding stem, whose rise against a graduated index shows the condition as to level of the water in the boiler.

Fig. 7106.




*Water-Gages.*

*f* and *g* are views of a *window-gage*, so called because a pane of glass in front of the boiler shows the float and the water-level. The float is suspended by a string over a wheel, whose oscillations move the finger on the dial.

Another form of glass-gage (*h*) is a tube having connection through hollow posts with the interior of the boiler, above and below the water-line respectively. The hight of the water iu the glass tube coincides with that in the boiler. Above it are gage-cocks.

Other water-gages are in the form of alarms: —

1. A tube let in to the top of the boiler has an open end descending below the proper water-line, and is crowned above with a whistle. When the water sinks below the desired level the water retreats from the tube, the steam enters and sounds the alarm.

2. A disk of fusible metal is placed in position in a tube, such as that last described. As long as the column of water is sustained in the tube by the pressure of steam within the boiler, the fusible disk remains intact; but when the water-level subsides below the mouth of the tube, the water runs out, steam rushes in, and the heat of the latter fuses the metal and the steam escapes, sounding an alarm.

3. A tube similar to the foregoing has a thermostatic rod, which, so long as the tube is filled with water, is not brought into action; but, as soon as the water leaves the tube and it becomes filled with steam, the metal is expanded by the increment of heat and actuates a valve-rod, which opens an escape for the steam and sounds an alarm.

See also LOW-WATER ALARM.

**Wa'ter-gas.** Gas obtained by the decomposition of water. Water in the form of steam is passed over red-hot coke, resolving it into hydrogen and carbonic oxide, the oxygen being absorbed. The hydrogen and carbonic oxide are then passed through a retort, in which carbonaceous matter, such as resin, is undergoing decomposition, absorbing therefrom sufficient carbon to render it luminous when burnt. See English patents, Cruickshanks, 1839; White, 1849.

**Wa'ter-gate.** A water-plug or valve.

**Wa'ter-gild'ing.** A mode of gilding by an amalgam in which the articles are pickled and then dipped in or brushed with a dilute solution of nitrate of mercury and gold, called *quick-water*, which leaves a film of amalgam on the surface.

The gold is dissolved in ten times its weight of mercury; the amalgam is strained through leather and dissolved in dilute nitric acid. After dipping, the articles are exposed to heat in a cage within a furnace, and the mercury thus driven off. The gold surface is then polished with a bloodstone-burnisher.

**Wa'ter-glass.** A silicate of soda or potash soluble in boiling water, and applied to various purposes in the mechanical and fine arts. See SOLUBLE GLASS.

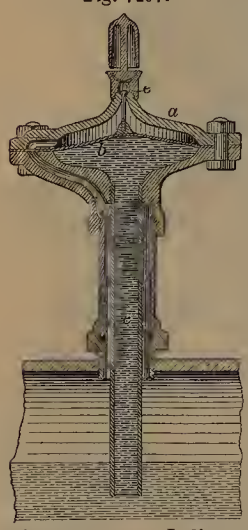
**Wa'ter-heat'er.** See HEATING-APPARATUS.

**Wa'ter-hole.** (*Mining.*) A place where the water collects; a *sump*.

**Wa'ter-in'di-ca'tor.** A *float*, *gage-glass*, etc., arranged to show the hight of water in a boiler or tank (see WATER-GAGE); or to give an alarm if it be decreased below a certain level. See WATER-GAGE; LOW-WATER ALARM, page 1359.

Millward's indicator is designed for showing that there is either an excess or deficiency of water in the boiler.

Fig. 7107.




*Millward's Water-Indicator for Boilers.*

The low-water indicator is shown in Fig. 7107. It consists of a chamber *a*, divided by an elastic diaphragm *b* into two portions, the lower one of which is filled with water, and communicates by the pipe *c* with the water in the boiler; a passage *d* establishes a communication between the steam-space and the upper division of the chamber *a*. Connected to the top of the diaphragm *b* is an upwardly opening valve *e*, raised when in normal position by the tension of the diaphragm. So long as the level of the water in the boiler does not fall below the lower end of the pipe *c*, the downward pressure of the column of water in the pipe, aided by the atmospheric pressure on the upper surface of the valve *e*, more than counterbalances the steam-pressure on the upper surface of the diaphragm; but when the water-level in the boiler falls below the end of the pipe, the water in the latter escapes, and each side of the diaphragm being then exposed to an equal steam-pressure, with the exception of a part equal in area to the valve-seat, which is counterbalanced only by the atmospheric pressure, the elasticity of the diaphragm causes it to assume its normal position, the valve rises, and permits steam to escape.

The high-water indicator is similar in construction, but has a downwardly opening valve, which is closed when the diaphragm is exposed to a boiler-pressure of steam on both sides. It is opened by the deflection of the diaphragm when there is an unbalanced pressure due to the presence in tube *c* of a hydrostatic column.

A piston sliding in a cylinder may be substituted for the diaphragm, and other modifications made in the instrument, without affecting the principle of its construction.

**Wa'ter-in-fork.** (*Mining.*) When all the water is extracted.

**Wa'ter-ing.** 1. (*Flax.*) The soaking of flax halm to loosen the *shives* from the *hare* and remove the mucilage. *Steeping; Retting.*

2. (*Fabric.*) A process of giving a wave-like appearance to fabrics, by passing them between metallic rollers variously engraved, which, bearing unequally upon the stuff, render the surface unequal, so as to reflect the light differently. Watering silk is said to have been invented by Octavius May, at Lyons, seventeenth century. See MOIRE, etc.

In 1780, the mode of ornamentation was by pressing between figured steel plates. Steel cylinders were introduced afterward. "Moire silk for watering is made of double width, which is indispensable in obtaining the bold waterings, for these depend not only on the quality of the silk, but greatly on the way they are folded when subjected to the enormous pressure in watering. They should be folded in such a manner that the air which is contained between the folds of it should not be able to escape easily; then, when the pressure is applied, the air, in trying to effect its escape, drives before it the little moisture that is used, and hence causes the watering. The pressure is from 60 to 100 tons." — BAMBER.

**Wa'ter-ing-bri'dle.** For artillery service it is composed of one bit and one pair of reins. The bit is of blued wrought-iron, made in two pieces united at the middle by a loop hinge. Their ends have holes to receive the two rings to which the reins are sewed. Two chains and toggles are welded into the rein-rings. The reins are sewed to each other at one end, and to the rings at the other.

**Wa'ter-ing-buck'et.** In the United States service the regulation bucket is made of sole leather, fastened with copper rivets and having a copper rim. These are very durable, but expensive. A much cheaper bucket is made of gutta-percha, but it has not the endurance of the leather article.

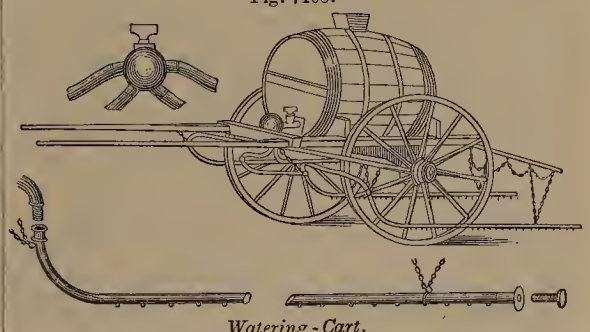
**Wa'ter-ing-can.** (*Founding.*) This, with a rose, is of the usual form employed by gardeners, but, like the shovel and sieve, is so indispensable a molder's implement with which to keep the sand of the right degree of moisture, that it should be cited here.

**Wa'ter-ing-cart.** A cart designed for watering plants in drills.

It was designed by Young (Scotland), and has 4 pipes, each having 20 small orifices; the 4 pipes are intended to pass along as many drills, sprinkling each. The barrel is estimated to carry 200 gallons. The tubes are 5 feet long, $\frac{3}{4}$ inch caliber; the aspersion taking place through an opening of $\frac{1}{16}$ inch.

The water in the reservoir will be discharged in 2 hours 20 minutes. A horse going $2\frac{1}{2}$ miles per hour will go $5\frac{5}{8}$ miles in the time. The width of ground covered by the 4 pipes is $6\frac{3}{4}$

Fig. 7108.



*Watering-Cart.*

feet. The area of the surface watered from 1 barrelful in the time mentioned will be over 4¾ acres.

**Wa'ter-ing-pot.** Mentioned by Pollux, and much later by Montfaucon, Du Cange, and Shakespeare.

**Wa'ter-in-ject'or.** A form of pump used on steam-boilers. See INJECTOR.

**Wa'ter-laid.** (*Rope.*) Coiled "against the sun," that is, over to the left. *Cablet.*

**Wa'ter-laid Rope.** Rope laid up and twisted "against the sun," as it is termed; in contradistinction to *right-hand* rope.

**Wa'ter-leg.** A vertical water-tube in a steam-boiler connecting other water-spaces and crossing a flue-space by which its contents are heated. In Galloway's boiler the flue is large, and the *water-legs* form stays.

**Wa'ter-lev'el.** A level consisting of a trough or tube partially filled with water.

A tube with upturned ends will show the level position by the even rising of the water in the ends. This is the *libra aquaria* of the Romans, described by Vitruvius as the *chorobates.* See LEVEL.

Another *water-level* consists of two cups fitted to the ends of a straight cylindrical tube of an inch in diameter and three or four feet long, by which the water freely communicates from one cup to the other. The tube is movable on its stand by means of a ball and socket, and thus the surfaces of the water, when the cups are equally full, show the line of level. This is also described by Vitruvius as the *libra aquaria.*

The cups may constitute chambers, and floating pistons on the surfaces of the liquid may indicate by graduated stems the condition of the level. Invented by Parker.

**Wa'ter-line Mod'el.** (*Shipbuilding.*) A model formed by board shaped according to the draft-lines on the paper, and laid upon each other to form a solid model. A *key-mold.*

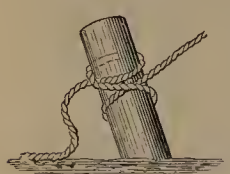
**Wa'ter-lines.** 1. (*Shipbuilding.*) Ship's lines drawn parallel with the surface of the water, at varying hights. In the *sheer plan* they are straight and horizontal; in the *half-breadth plan* they show the form of the ship at the successive hights marked by the *water-lines* in the sheer plan.

2. (*Nautical.*) The line up to which the hull of a vessel is submerged in the water.

*Load water-line:* the line to which a ship sinks with all her cargo and stores on board.

**Wa'ter-lute.** A diaphragm or curtain whose lower edge is submerged in water, and which acts to prevent the passage of air while the liquid is allowed to flow. An *air-trap.*

Fig. 7109.



*Waterman's Knot.*

**Wa'ter-man's Knot.** A sailor's mode of bending a rope to a post or bollard.

**Wa'ter-mark.** (*Paper-making.*) Any distinguishing device or devices indelibly stamped in the substance of a sheet of paper while yet in a damp or pulpy condition.

The practice dates to at least as far back as the early part of the sixteenth century, or soon after the introduction of printing. In the old process of hand paper-making the bottom of the mold was formed of a close series of parallel wires supported by a few others at right angles to them. The impressions of these are distinctly visible in old sheets of paper; but what is distinctively known as the water-mark is made by a wire sewed to the surface of the mold so as to make the paper thinner where it is prevented by the wire from coming in direct contact with the longitudinal wires. The water-marks used by the earlier paper-makers have given names to several of the present standard sizes of paper, as *pot, foolscap, crown, elephant, fan, post,* the latter dating from the year 1670, when a general post-office was established in England, and formerly bearing the device of a postman's horn; the first was in use at least as early as 1530.

Up to the year 1855, the very elaborate water-mark employed by the Bank of England, which for a long series of years had its paper made at one mill in Hampshire, was formed by affixing wires to the molds as above indicated, involving, in a pair of molds for the production of the device, several hundred thousand stitches.

At present, the device representing the water-mark is stamped in the fine wire gauze of the mold itself. The design is engraved on a block, from which an electrotype impression is taken; a matrix or mold is similarly formed from this; these are subsequently mounted upon blocks of lead or gutta-percha, to enable them to withstand the necessary pressure, and serve as a cameo and intaglio die, between which the sheet of wire gauze is placed to receive an impression in a stamping-press. By this means the tones of the original are reproduced in the paper, the deepest shadows of the water-mark corresponding to the deepest engraving on the die, and the lighter shades to the shallower parts. In the hand process, the wire thus treated constitutes the mold itself; but in the machine, it forms the periphery of the *dandy,* or first roller, under which the paper passes in its progress from the vat along the endless wire web, and beneath which are the vacuum-boxes by which the water is sucked out of the pulp.

**Wa'ter-me'ter.** A device for measuring the amount of water received or discharged through an orifice.

Water-meters may be divided into seven classes: —

1. Those in which the water is passed through a horizontally rotating case having a peripheral discharge, or fixed case containing a horizontal wheel with spiral flanges, like a turbine, and delivering a known amount at each rotation.

2. A piston or wheel with vanes or buckets rotating in a chamber and operated by the pressure of the water. These act on the principle of the rotary steam-engine, and are the converse of the rotary pump, in which the *rotating piston drives the water.*

3. The Archimedean screw rotating in a tube.

4. A piston reciprocating in a cylinder of known capacity. This acts on the principle of the ordinary steam-engine, in which the steam drives the piston, and is the converse of the ordinary force-pump, in which the piston drives the water.

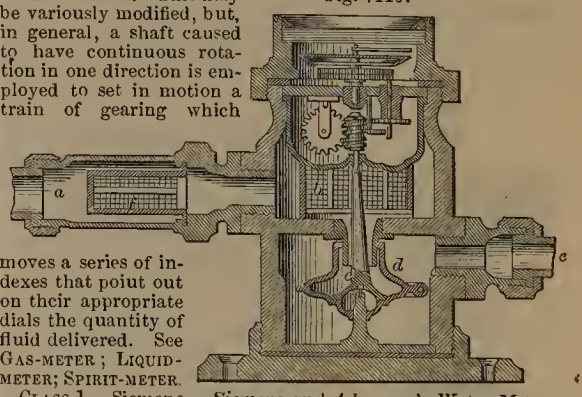
5. The *meter-wheel.*

6. The pulsating diaphragm, which displaces the water from its respective sides alternately, and is the converse of the old Cracknell pump (English).

7. The bucket and balance-beam, in which the reservoirs of known capacity on the respective ends of the beam are alternately presented to catch the water, and are depressed and emptied as they become filled.

Whichever of these principles be adopted, the number of oscillations, reciprocations, or rotations, each of which permits a definite quantity of the fluid to pass through the meter, must be registered by appropriate mechanism. This may be variously modified, but, in general, a shaft caused to have continuous rotation in one direction is employed to set in motion a train of gearing which moves a series of indexes that point out on their appropriate dials the quantity of fluid delivered. See GAS-METER; LIQUID-METER; SPIRIT-METER.

Fig. 7110.




*Siemens and Adamson's Water-Meter.*

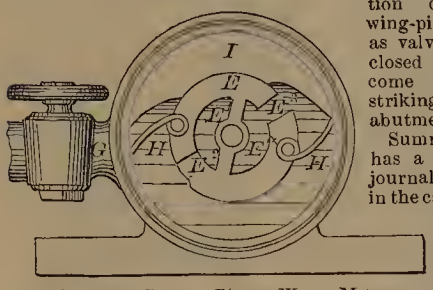
CLASS 1. Siemens and Adamson's meter acts on the principle of Barker's mill. The water is conveyed by a tube *a* to a horizontal drum *d*, rotating on a vertical shaft *c*, having at its upper end a worm which communicates motion to the registering gearing. The drum has three or more tangential apertures at its periphery, and discharges a given amount of water at each revolution, which is carried away by the pipe *e*. *b f* are gratings to arrest impurities.

See also Fig. 2970, *A*, page 1327.

CLASS 2. In Turner's meter (Fig. 7111), water admitted through the pipe *G* enters alternately into the hollow rotary piston *E* through the openings $E^2$ $E^3$, and passing behind the pivoted wing-pistons *H H*, causes continuous motion in one

direction. The water entering the chambers $E^1$ $E^{1x}$ is discharged as each port arrives at the eduction opening. The wing-pistons also act as valves, and each is closed in so as to become inoperative by striking against the abutment *I*.

Fig. 7111.

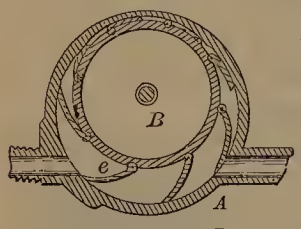



*Turner's Rotary Piston Water-Meter.*

Summer's (Fig. 7112) has a rotary disk *B* journaled eccentrically in the case *A*, which has a shallow, lunate cavity at its upper side, concentric with the disk, to give longer packing surface to the pivoted wings *e*, which bear against the side all around. See also Figs. 2970, *C*; 2971, pages 1327, 1328.

See also ROTARY PUMP, Figs. 4465, 4466; ROTARY METER, Fig. 4461; ROTARY STEAM-ENGINE, Plate LIII., page 1990, etc.

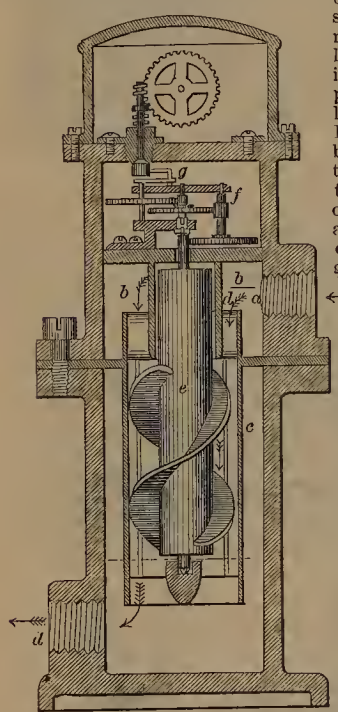
Fig. 7112.




*Summer's Rotary Piston Water-Meter.*

CLASS 3. Maxim's meter (Fig. 7113) is of the screw-shaft class. The liquid entering through the opening *a* is received in a chamber *b*, flows downward through the square trunk *c*, and is discharged at *d*. The trunk *c* has a vertical inwardly projecting web at each angle, just cleared by the wings of the screw, and preventing the water from acquiring a rotary motion. A casing *d* prevents the water from causing a lateral displacement of the screw-shaft. The shaft *e* is hollow, and is made slightly more buoyant than water, so that when a small quantity only is flowing, the shaft will be buoyed up and turn upon its upper pivot, which is made sharp and delicate, so that the resistance is reduced to a minimum; but when a larger quantity of water is passing, the shaft is depressed, and turns on its lower and larger bearing. Bicarbonate or supercarbonate of soda and dry tartaric acid are placed in the shaft, so that in case of water sweating through, a combination ensues, causing the evolution of a gas which resists the farther entrance of water and maintains the buoyancy of the shaft.

Fig. 7113.




*Maxim's Archimedean-Screw Water-Meter.*

A train of gearing in the chamber *f* communicates, through the medium of a crank and arm connection *g*, rotary motion to a shaft passing through a water-tight plug and actuating the indicating mechanism. See also Fig. 2972, page 1328.

CLASS 4. The *reciprocating piston.*

Worthington's double-piston meter ("Pioneer") has two parallel cylinders, in each of which are two pistons connected by a stem and acting together as a double piston. The space between the pistons is greater than the stroke, is filled with water, and contains the mechanism which actuates the valves. Under the central space of each set of pistons is placed the slide-valve of the other set, so that each piston in its motion actuates the valve to admit water against the other piston, the action being reciprocal.

A somewhat different construction, which has its analogue in many modern steam-engines and steam-pumps, is that in which two pistons and two valves or sets of valves are employed. One piston is smaller than the other, and operates in a cylinder connected by a port with the larger cylinder. The duty of the smaller piston is to operate the valve of the larger one. The larger piston in its motion actuates a small valve, admitting water to the smaller cylinder; the pressure of water in the latter operates the smaller piston, and this actuates the main valve.

Somewhat similar is the construction adopted by the Hudson Brothers in their steam-pump, and it likewise is applicable to liquid meters. The larger piston in its motion uncovers a port leading to the smaller cylinder; the pressure of water in the latter actuates the small piston, and this moves the valve. But one valve is thus used at each end of the double-acting apparatus. The valve-apparatus of R. C. M. Lovell's steam-quarrying machine is thus constructed.

George I. Washburn's engines, whose construction adapts them to be used as meters, are suggested by the foregoing remarks on the Worthington meter. In Washburn's, two piston-stems are used, reciprocating in their several cylinders, and each having a plurality of disks. Though his numerous engines vary in details, the feature of a plurality of disks on pistons reciprocating in separate cylinders is preserved. In most of his engines, the piston of each cylinder is alternately a working piston and a valve, each governing the admission and exit of steam (or water) to the other cylinder, reciprocally. In some other of his engines, the valve-stem is connected by a *reach* to the working piston.

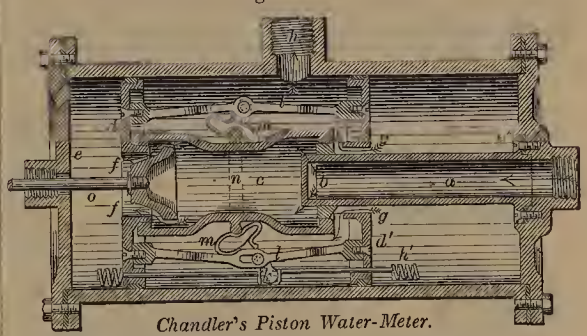
As it is not desirable to duplicate cuts in a work where they are necessarily so numerous, we refer the reader to STEAM-ENGINE, where the above and other steam-engines capable of adaptation as water-meters will be found described. It is, however, proper to remark in this connection, that this feature of making one reciprocating piston act as a valve to another similarly moving piston is found in the old and the new steam-hammer. The main piston in its descent, for instance, uncovers a port which admits steam to a piston-valve, whereby the steam induction is accomplished. See also PISTON-VALVE.

The Jopling meter (English) consists of "two short, double-acting cylinders and pistons, each cylinder supplied at the side with a common D slide-valve, in appearance precisely like two steam-engine cylinders with usual pistons and slide-valves, with the only difference that the port in one of the latter is reversed. These cylinders are so placed opposite each other that the piston-rod of the one at the end of its stroke can move the valve of the other on the 'tappet' mode, and *vice versa*. The whole is surrounded by a strong casing full of the water to be measured. The mode of operation is similar to that of Worthington's meter, with the exception that the pistons have no dead-water to carry with them. The piston-rods, however, pass through stuffing-boxes, which in the Worthington meter is avoided."

See also Fig. 2974, page 1328.

The Hicks meter is adapted from his ingenious steam-engine, in which the cylinders are situated radially around a central space occupied by the common crank, to which their piston-rods are attached. The piston-rods of opposite cylinders, being continuous or practically so, may thus be considered as one,

Fig. 7114.



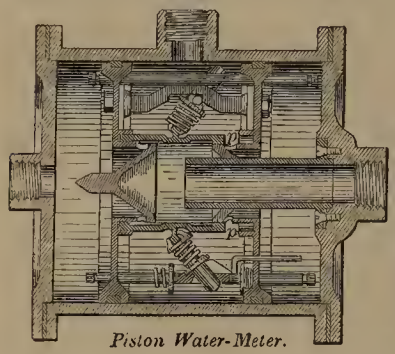

*Chandler's Piston Water-Meter.*

having a piston operating in two opposite cylinders, with a steam (or water) space between them. The effective strokes of the pistons are made consecutively, each commencing a stroke at each quarterly point in the revolution of the main shaft. In the meter the main shaft is connected to a register which records the revolutions, each revolution representing on the index (in gallons, for instance) the sum of the capacity of the several cylinders. No valves of ordinary construction are used, but each cylinder and piston has ports so arranged as to form induction and eduction passages. Each of the pistons forms an induction-valve for the piston in advance and an eduction-valve for the piston in the rear.

Chandler's meter (Fig. 7114) is one of the reciprocating-piston class. The water, entering by the induction-pipe *a*, passes through ports *b* to the interior of a valve *c*, having a reciprocatory motion within the piston, which consists of two heads *d* *d'* connected by rods *l l*; flowing through the ports *f f*, it forces the piston away from the head *e* of the case toward the head *e'*, the water contained between the latter and the head *d'* of the piston passing through the ports *g g* between the valve and the piston to the discharge-opening *h* of the meter. On approaching the

head $e'$, the spiral spring $h'$ on the rod $i$ strikes against this head, reversing the movement of the valve by means of a lever $k$, one end of which is pivoted in a slot in one of the stays $l$ and connected with one of two elliptical springs $m$ having a depression in which a collar $n$ centrally surrounding the valve rests. This movement of the valve closes the ports $f f$ and opens the corresponding ports between the valve and piston, producing a reverse movement of the piston, and causing the water which had accumulated between the heads $d$ $e$ of the piston and meter to flow between the valve and piston at that end toward the discharge-opening.

Fig. 7115.



*Piston Water-Meter.*

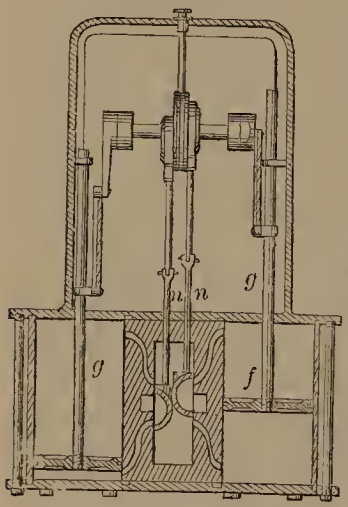
The piston-rod $o$ is connected with suitable mechanism for registering its reciprocations.

Fig. 7115 shows another form of this meter, having a differently arranged spring and rod for causing the throw of the valve, which is cushioned by annular water-chambers $p$ $p$ at each end of the piston.

In a third modification, the valve is shifted by a weighted forked lever partially embracing it and connected with the sliding rod.

The Despers water-meter has two connected pistons, a valve, and registering-pinion.

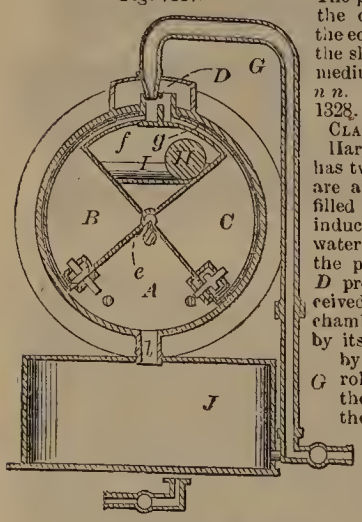
Fig. 7116.




*Spencer's Piston Water-Meter.*

In Spencer's (Fig. 7116), two measuring-chambers $f$ $g$ act alternately to receive and discharge the water The case containing the operating parts is tight, and is so constructed as to form the heads of the cylinders, whereby stuffing-boxes are dispensed with. The pistons are connected to the cranks of the shaft of the eccentrics, which operate the slide-valves through the medium of connecting-rods $n$ $n$. See also Fig. 2974, page 1328.

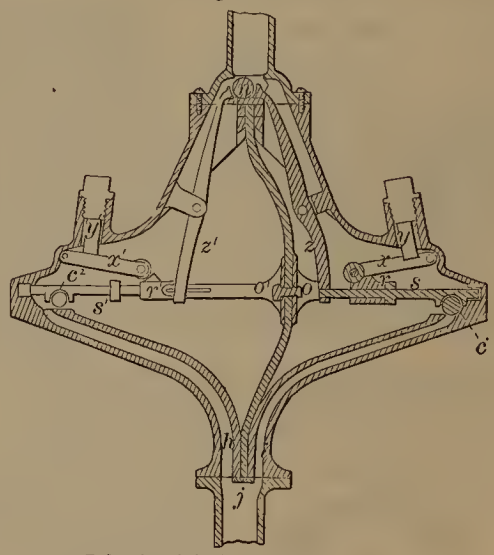
Fig. 7117.




*Meter-Wheel Water-Meter.*

Class 5. *The meter-wheel.* Hargrave's meter (Fig. 7117) has two chambers $B$ $C$ which are alternately tilted to be filled with water from the induction-pipe $G$ $G$. The water flows in turn through the pipes $f$ $g$, the partition $D$ preventing its being received into the opposite chamber. When full, it is, by its own gravity, assisted by the weight $H$, which rolls from side to side on the track $I$, tilted until the projecting stem of a valve at its lower angle strikes a stop in the chamber $A$, which opens the valve and allows the water to escape into this chamber, whence it passes through opening $l$ into an air-chamber $J$, or direct to the place of delivery. In the mean time the other chamber is being filled, to be tilted in its turn. The chambers $B$ $C$ are balanced on a knife-edge $e$, and the induction and eduction cocks are arranged to be simultaneously opened and closed. See also Liquid-meter, Fig. 2970, $A$.

Fig. 7118.




*Pulsating-Diaphragm Water-Meter.*

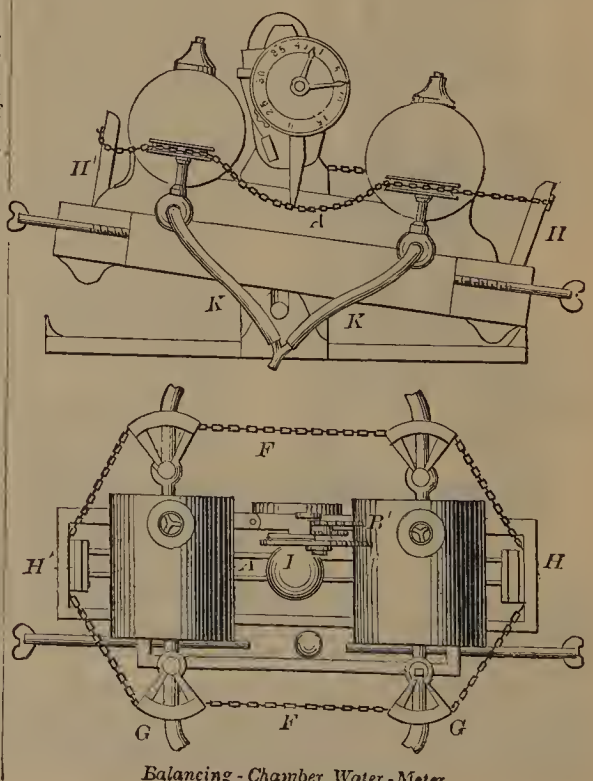
Class 6. The *pulsating diaphragm.*

Baldwin's meter (Fig. 7118) has an elastic diaphragm dividing it into two chambers, each having an inlet and outlet aperture, the former provided with a valve $n$, and the latter having the separate valves $c^1$ $c^2$. The diaphragm is centrally attached to a sleeve $o$ $o'$ sliding on the rod $s$ $s'$, and which, as it moves alternately from side to side through the medium of the levers $z$ $z'$, moves the valve $n$ so as to close one and open the other of the induction-openings. The same movement operates to open one and close the other of the eduction-openings, a rapid motion being imparted to the rod $s$ $s'$ toward the end of each stroke by the arms $x$ $x'$, which have friction-rollers on their ends acting against the wipers $r$ $r'$, and are actuated by springs $y$ $y$. The eduction-passages $h$ $i$ coalesce in a single pipe. See also Fig. 2970, $B$ (two figures).

Class 7. The *bucket and balance.*

Weller's (Fig. 7119), though adapted for use as a water-meter, is more particularly designed for oil, spirits, etc. It consists of a box or frame $A$ $A$, on which are mounted two casks of equal capacity, and rocks upon a central pivot. Two levers $H$ $H'$ are connected by chains $F$ $F$ to quadrants $G$ $G$ or their equiva-

Fig. 7119.




*Balancing-Chamber Water-Meter.*

lents, which operate to open the induction and close the eduction cock of each cask when it is tilted into elevated position, and *vice versa*. When a cask becomes filled, its weight overcomes that of the empty cask and that of a ball *I*, which runs in ways, and is then at the depressed end of the box; but as that end rises, the ball rolls toward the other end, and, striking the lever *H* at that end, causes it to pull the chain so as to open the eduction and close the induction cock of the lower cask, while opening the induction and closing the eduction cocks of the upper one. The flexible discharge-tubes *K K* belonging to each cask coalesce in a single tube.

An adjusting-ball *B'* is provided for graduating the preponderance of the ends of the box, to adapt the meter for liquids of different gravities. See also Fig. 2973.

**Wa'ter-mill.** Water-mills were probably invented in Asia.

One is described near one of the palaces of Mithridates of Pontus, 70 B. C. See GRINDING-MILL.

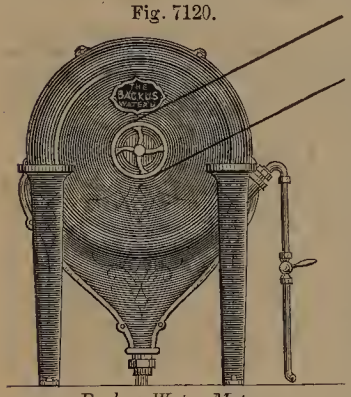
Strabo speaks of one on the Tiber, 70 B. C.

Antipater, the contemporary of Cicero, alludes to one in an epigram.

Vitruvius, 50 B. C., describes their construction as similar to the *tympanum*, with circumferential floats or paddles which were acted upon by the force of the stream, driving the wheel round. On the axis of the water-wheel was another wheel with cogs, which meshed into the cogs of a horizontal wheel, on the upper head of whose axis was a tenon inserted in the millstone.

Pliny refers to water-mills (died A. D. 79).

Fig. 7120.

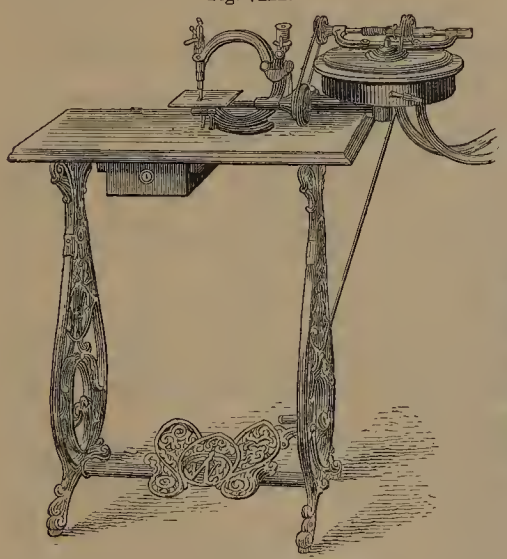


*Backus Water-Motor.*

Public water-mills were established in Rome in the time of Honorius and Arcadius (A. D. 398). They were driven by the water of the aqueducts.

When the Goth Vitiges besieged Rome, A. D. 555, he caused the water-supply of the fourteen aqueducts to be cut off, and reduced the people to great straits for meal. Procopius says that below the bridge which reaches the walls of the Janiculum, Belisarius extended ropes, well fastened and stretching across the river, secured on both banks; to these he moored two boats of equal size, separated by a small space in which a water-wheel revolved and turned the grain-mills erected on the boats. At different places on the river, where the current was strongest, he arranged other mills, and thus ground a sufficient provision for the city. This was in the reign of Justinian.

Fig. 7121.



*Lane Water-Motor, attached to a Sewing-Machine.*

**Wa'ter-mo'tor.** An application of the water-wheel to purposes of a domestic nature, such as running sewing-machines, organs, etc., being driven by water from the customary city mains.

See also devices in ROTARY PUMP, ROTARY STEAM-ENGINE, etc., which may be adapted to be driven by the force of a current of water. This is the converse of the condition first stated, where the engine raises the water; as it is a mere substitute of water for steam in the last-mentioned case.

**Wa'ter-pack'er.** (*Well-boring.*) A cap on the top of a pipe to exclude surface-water.

**Wa'ter-pil'lar.** A hollow standard and overhung arm for supplying a tender with water. Also known as a *water-crane*, from its form. It has a revolving swan neck, and the valve is operated by a hand-wheel, rods, and miter gear. Also called a WATER-CRANE (which see).

**Wa'ter-pipes.** James Watt devised sectional water-pipes with flexible articulations to enable the pipe to accommodate itself to the inequalities of a river bottom across which the water was to be conveyed. He derived the suggestion from the articulations of the tail of a lobster.

See PIPE, for enumeration of kinds and purposes.

"The water brought from the mountains of Cordova was conveyed to the palace of the Khalifs, and thence distributed into every corner and quarter of the city by means of leaden pipes, from which it flowed into basins of different shapes made of the purest gold, the finest silver, or plated brass, as well as into vast lakes, curious tanks, and amazing reservoirs, and fountains of Grecian marble, beautifully carved. In this palace, too, was an astonishing *jet d'eau*, which raised the water to a considerable hight, and the like of which was nowhere to be seen in the East or West." — MAKKARIS (*Arabic*), *History of the Mohammedan Dynasties of Spain*.

**Wa'ter-plate.** One heated by water in the jacket, to keep the viands warm. Count Caylus has engraved a very handsome specimen of one.

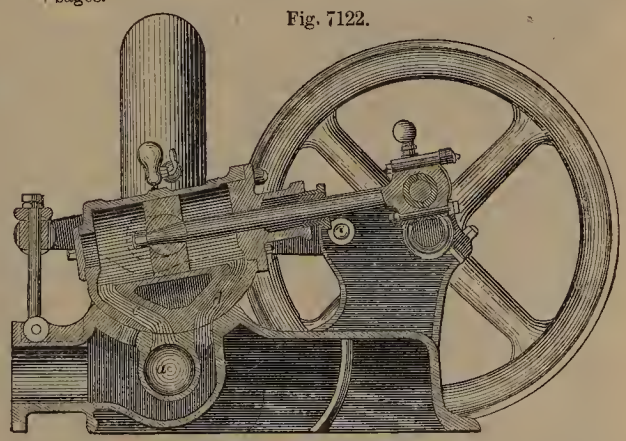
**Wa'ter-press.** Another name for the HYDROSTATIC PRESS (which see).

**Wa'ter-press'ure En'gine.** An engine used where there is a considerable fall of water of moderate quantity. It is used in some of the German mines. The water under pressure drives a pistou in a cylinder, somewhat in the manner of steam.

The name is sometimes applied to the turbine-wheel, which was first used on the Continent of Europe, and, in some remarkable instances, falls of several hundreds of feet are thus utilized. See TURBINE; HYDRAULIC ENGINE; WATER-ENGINE; WATER-MOTOR.

Fig. 7122 shows Schmid's oscillating-cylinder water-engine (Swiss). The steam-passages are in the lower face of an arc having its center at the trunnions, *a* being the main water-pipe, and *c d* becoming alternately the induction and eduction passages.

Fig. 7122.

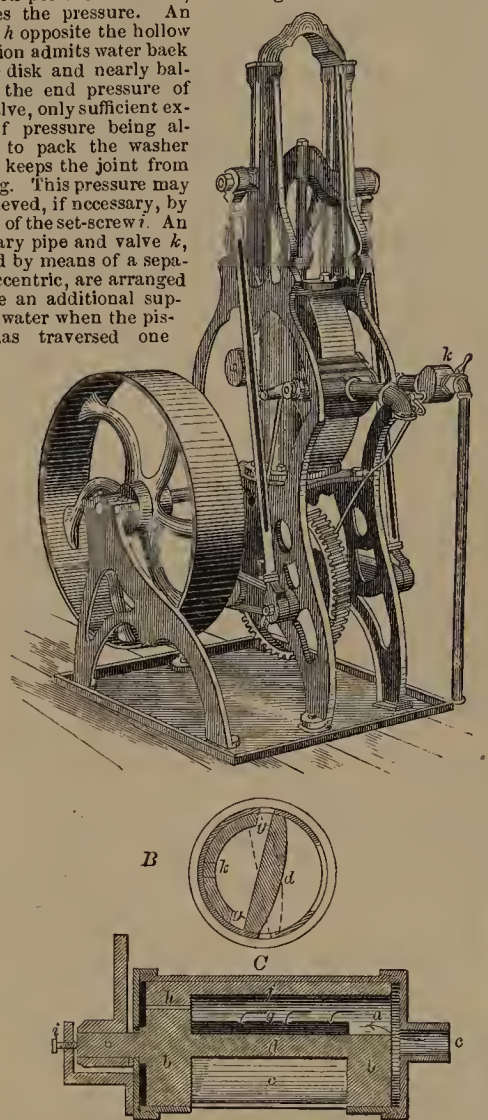


*Water-Pressure Engine.*

The Coates and Lascell engine (Fig. 7123) is of the vertical kind. The valve shown at *B C* is balanced and self-packing. The induction-port *a* is located at one end in one of two transverse disks *b* at the end of the valve. These fit closely the interior of the valve-chest *c*, and are connected by a flat plate *d*. A hollow trunnion *e* admits the water, which flows in the direc-

tion of the arrows into the valve-chest. A curved plate *f*, having openings *g* serving as eduction-ports for the valve, diffuses the pressure. An orifice *h* opposite the hollow trunnion admits water back of the disk and nearly balances the end pressure of the valve, only sufficient excess of pressure being allowed to pack the washer which keeps the joint from leaking. This pressure may be relieved, if necessary, by means of the set-screw *i*. An auxiliary pipe and valve *k*, opened by means of a separate eccentric, are arranged to give an additional supply of water when the piston has traversed one

Fig. 7123.




*Water-Pressure Engine.*

fourth of the length of the cylinder, so as to equalize the motion of the crank.

**Wa'ter-press'ure Pump.** (*Hydraulics.*) A machine for using the pressure of a body of water to raise a smaller quantity to a greater elevation, as to the upper stories of houses where the pressure in the water-mains and regular service is not sufficient.

The pump is placed in the cellar of the house, attached to the service-pipe between the street-main and the kitchen. All the water used in the house passes through it, works its pistons, and forces a percentage to a reservoir on the top story for distribution.

It moves when water is drawn, and is at rest as soon as it is stopped, so that the free use of the water in the lower part of the house supplies that part which is higher than the city pressure.

It may be worked with brook-water, the pump taking its supply from a spring.

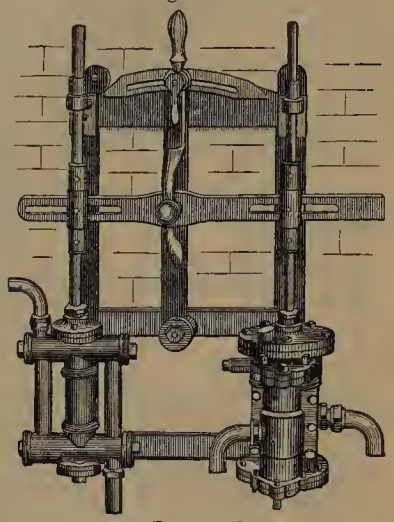
## Wa'ter-proof Glue.

Dissolve one ounce of gum-sandarac and one ounce of mastic in half a pint of alcohol, and add one ounce of clear turpentine. At the same time a very thick glue is to be prepared and added to the first-mentioned solution, both of them heated almost to the boiling-point, and stirred intimately together. After mixture, it is to be strained through a cloth, when it will be ready for use. This glue is to be applied hot.

**Wa'ter-proof'ing.** The process of rendering any substance impervious to water.

Its principal application is to textile fabrics; many solutions and compositions having been employed for the purpose, among which may be enumerated petroleum; whiting and water; alum, white lead, and water; the same ingredients, with acetic acid added; tar, for tarpaulins; oil, for oil-skins; a mixture of boiled linseed-oil, pipe-clay, burnt umber, white lead, and pumice-stone, for tarpaulins, coach-covers, awnings, etc. India-rubber has now nearly superseded all other agents for water-proofing textile fabrics. See INDIA-RUBBER.

Fig. 7124.



*Water-Pressure Pump.*

Dr. Reimann's process consists in precipitating an insoluble salt, as sulphate of lead, in the fiber of the cloth by drawing it through a tank divided into three compartments: the first containing a warm solution of alum; the second, warm solution of acetate of lead; and the third, pure water, which is kept constantly renewed. The cloth is then beaten and brushed, to remove the salt adhering to the exterior, and finally hot-pressed and brushed. Cloth thus treated, it is claimed, is rendered impervious to water, but permits air to pass freely through it.

## Wa'ter-proof'ing Leath'er.

A number of special compositions have been employed for rendering leather water-proof by filling up the minute pores. Among them are: 1. Boiled linseed-oil, mutton suet, yellow beeswax, and rosin, melted and applied while hot to the leather slightly warmed. 2. Linseed-oil, rosin, white vitriol, spirits of turpentine, and white-oak sawdust. 3. Yellow beeswax, Burgundy pitch, turpentine, and linseed-oil. 4. Two parts tallow and one rosin. 5. Apply a coating of tallow to the leather, and afterward a second coating of one part copaiba balsam and two naphtha. 6. Caoutchouc, boiled for two hours in linseed or neatsfoot oil.

## Wa'ter-proof'ing Pa'per.

Szerlmley's process is as follows: *a*, 30 ounces of glue, gelatine, or size, and 3 ounces of gum-arabic, are melted in 10 pints of hot water; *b*, 20 ounces of soap and 4 pounds of alum are also melted in 30 pints of hot water, and the compounds *a* and *b* are mixed, constituting composition No. 1. ½ gallon benzole and 1 gallon paraffine oil are mixed and heated, and 24 ounces resin melted in; to these, resin, oil, and copal, or mastic varnish, may in some cases be added; the whole is boiled to a moderate degree of consistency, forming composition No. 2. The article to be water-proofed is dipped in composition No. 1 and dried, and afterward composition No. 2 is applied with a brush or in other convenient manner.

A water-proof packing-paper is made by first coating the paper with a resinous liquid; it is then painted over with a solution of glue and soot; when this is dry, the water-proofing compound is applied with a brush. This is prepared by dissolving 2½ ounces of shellac in 2 pints of water, which is gradually brought to a boiling heat, the shellac being stirred until thoroughly dissolved and softened, when ½ ounce pulverized borax is gradually added, until the whole becomes intimately incorporated. While hot, any mineral color, as lampblack, red or yellow ocher, or umber, may be added; when cold, it is ready for use.

Another recipe for water-proofing paper is to pass the paper rapidly over and in contact with the surface of a solution of oxide of copper in ammonia. It is then drawn in succession between two pressing-cylinders and two drying-cylinders. The solution slightly dissolves the cellulose of the paper, converting it into an impermeable varnish.

Another recipe consists in soaking good paper in an aqueous solution of shellac and borax. It resembles parchment-paper in some respects. If the aqueous solution be colored with aniline colors, very handsome paper, of use for artificial flowers, is prepared.

**Wa'ter-proof Safe.** A floating safe for marine emergencies.

Garlick's water-proof safe consists of an interior and exterior casing of sheet-metal, the space between the two being divided into compartments which may be filled with cork or air. Double doors provided with water-tight packing are used, so

that in case of shipwreck or other contingency the safe will float if thrown overboard, without danger of injury to the contents.

**Wa'ter-pro-pel'ler.** A ROTARY PUMP (which see).

**Wa'ter-pump.** An air-pump in which a falling or driven body of water is made the means of inducing an exhaust current of air, or air and steam, from a room, a vacuum-pan, a condenser, etc.

The aspirator of the laboratory is constructed for assisting the filtering operation by withdrawing the air from the lower surface of the filtering material, so that the superincumbent atmosphere shall press upon the upper surface of the liquid and force it through the filter. (See ASPIRATOR.) The device is called *Bunsen's* pump; also *Sprengel*-pump.

Its uses in mechanics, besides the laboratory and hospital uses, are in removing steam from the steam-engine condenser and the pan for evaporating vegetable extracts, notably the vacuum-pan of the sugar-refinery. It is also used for obtaining an induced draft in *vacuum* ventilating-machines, and for forcing a current in *plenum* ventilating-machines. This may be effected by using the natural head, or by mechanically forcing the water through the pipe into which the air is drawn by entanglement with the passing water, on the principle of the Giffard injector, or by pulsative or intermittent action, as in one illustration under ASPIRATOR. See also TROCAR.

**Wa'ter-ram.** See HYDRAULIC RAM, page 1150.

**Wa'ter-ret'ting.** The process of *retting* or *rotting* flax or hemp by steeping in water, to soften the mucilage which binds together the fibrous and cellular portions. See RETTING.

**Wa'ter-room.** (*Steam.*) The space in a steam-boiler occupied by *water*, as distinct from that which contains *steam*.

According to Bourne, of the whole boiler-room, or internal capacity of the boiler, there are very nearly ¾ water-room and ¼ steam-room. According to Robert Armstrong, there are ½ water-room and ½ steam-room.

**Wa'ter-sail.** (*Nautical.*) A sail set in very light airs and smooth water, below the lower studding-sail booms and next to the water.

**Wa'ter-screw.** A water-elevator on the principle of the *Archimedean screw*, but consisting of an inclined axis with a spiral projection, rotating in a cylinder whose lower end is submerged. There is a loss of water between the thread of the screw and the casing. It differs from the ordinary Archimedean screw in this, that the latter has a spiral canal in which the flange of the screw is united with the casing, and the latter revolves therewith. See Fig. 4707.

**Wa'ter-shell.** An invention of Professor Abel of the English ordnance-department.

It is a common shell or cast-iron cylinder filled with water, into which is fitted a small cylinder containing a quarter, or, at the most, half an ounce of gun-cotton; it is then hermetically sealed; a few grains of fulminate of mercury are placed between the gun-cotton and the fuse, and, as soon as the latter is fitted, the shell is ready for firing.

**Wa'ter-snail.** The Archimedean-screw pump. Also called the *spiral pump*. The spiral water-channel is wound around an inclined rotating axis, and somewhat resembles the convolutions of a shell, but preserves the same latitude while progressing longitudinally in the direction of the axis of rotation. See Fig. 4707.

The *water-screw* has an inclined axis with spiral projection, and rotates within a cylinder whose lower end is submerged.

**Wa'ter-ta'ble.** A coping or projecting stone to shed the wet. It occurs on the various stages of buttresses, tops of battlements, etc.

**Wa'ter-test.** A test for the limpidity of water. Other qualitative and quantitative tests concern the ingredients; this, the color.

Mr. King, city analyst, Edinburgh, employs a solution of caramel, made by adding 10 grains by volume of solution of ammonium chloride (3.17 grains of the salt to 10,000 grains of water) to 8 ounces of pure distilled water, contained in a glass tube, which this quantity must fill to the hight of 12 inches. When under these conditions, 25 grains, by volume, of Nessler's solution are poured into the liquid, and the whole allowed to stand ten minutes at 60° Fah., the color will be uniform, and is graded by Mr. King at 30°, on a scale in which each degree contains 10 grains of caramel solution. It is to be observed that the thickness of the liquid stratum is always an important element in the graduation of color quantities. To estimate the color of a water, it is only necessary to fill two tubes, each 15 inches long, and of such a size that 8 ounces of water fills them to within 3 inches of the top. One is filled with distilled and the other with the water to be tested, and they are placed vertically over a white slab. The caramel solution is then carefully added to the distilled water, until its color, as seen by looking through the whole hight of the tube, is the same as that of the natural water. The quantity of caramel solution used indicates the degree of coloration, since 10 fluid grains correspond to one degree.

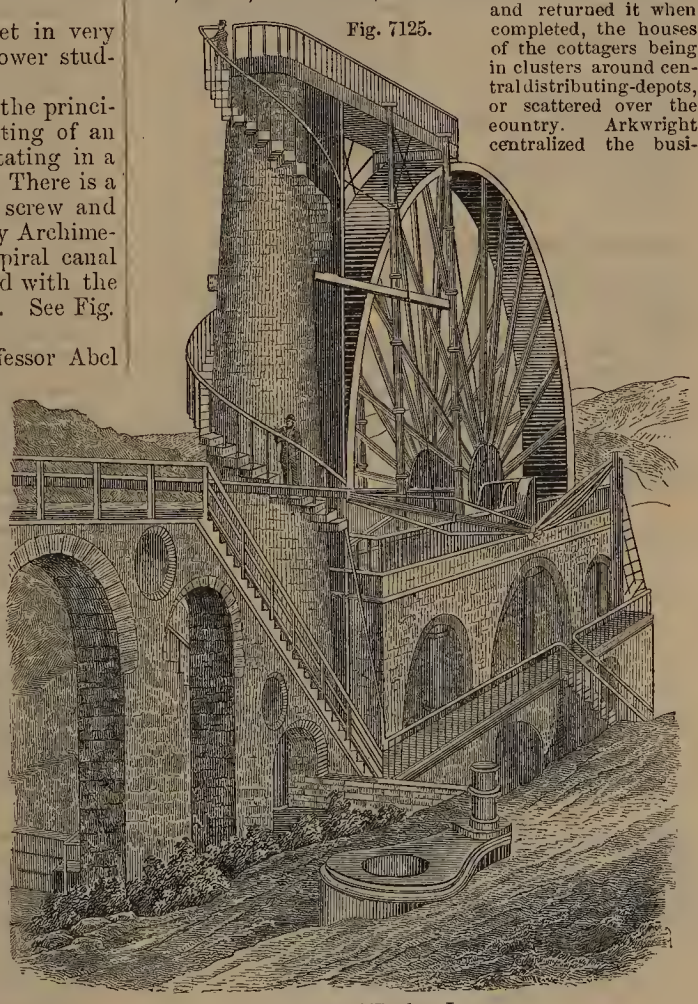
**Wa'ter-trunk.** A square rain-water pipe.

**Wa'ter-tube Boil'er.** A steam-boiler having tubes filled with water, and upon the outside of which the flame impinges. A *fire*-tube, or *flue*, is traversed *internally* by the flame or heated gases. See TUBULAR BOILER; a number are shown in Plate LIX.

**Wa'ter-twist.** (*Cotton-manufacture.*) Yarn made by the *throstle*, or *water-frame;* so called because in the first cotton-*mill*, which was organized by Arkwright, the motive-power was a *water-wheel*.

Previous to the time of Arkwright (his patents were 1769 and 1775), all the operations of cotton were done by operatives at their homes. The cotton was *hand-carded*, *spun*, and *woven* by men, women, and children, who took a bunch of work home and returned it when completed, the houses of the cottagers being in clusters around central distributing-depots, or scattered over the country. Arkwright centralized the busi-

Fig. 7125.



*Draining-Wheel at Laxey.*

ness, and organized it in manufactories where the operations were concertedly performed.

**Wa'ter-twist Frame.** The Arkwright spinning-machine for turning rovings into yarn, the first continuously working machine for *drawing*, *twisting*, and *winding*. See SPINNING, Fig. 5404.

**Wa'ter-way.** (*Shipbuilding.*) A strake on the inside of a vessel above the ends of the beams. It is bolted downward through the *beam* and *shelf*, and is bolted laterally through the *futtock* and *planking*. It is also secured by a fore-and-aft dowel to the beam. It forms a channel to lead the water to the scuppers.

In iron vessels it assumes many different forms, according to the judgment of the builders. See BEAM; SPIRKETING.

**Wa'ter-wheel.** A wheel which is turned by the action of water upon its floats.

In 1701, a lease for 381 years was made of the 4th arch of London Bridge for water-wheel purposes, to raise water for the city of London.

The 1st arch was leased in 1581 for the same purpose, for a term of 500 years.

The 5th and 2d arches were leased in 1767 for 315 years for the same purpose.

Fig. 7125 is an overshot water-wheel employed at Laxey, Isle of Man, for driving the pumps which drain the mines at that village; these have an extreme depth of 1,380 feet. The wheel is 72 feet 6 inches in diameter, 6 feet in breadth, exerts a force of about 200 horse-power, and is capable of pumping 250 gallons per minute from a depth of 400 yards. Its crank-stroke is 10 feet. The water for driving it is conducted by pipes from a reservoir on a neighboring hill, and ascends in the column of masonry shown to the left of the wheel.

Water-wheels are of many kinds. See under the following heads: —

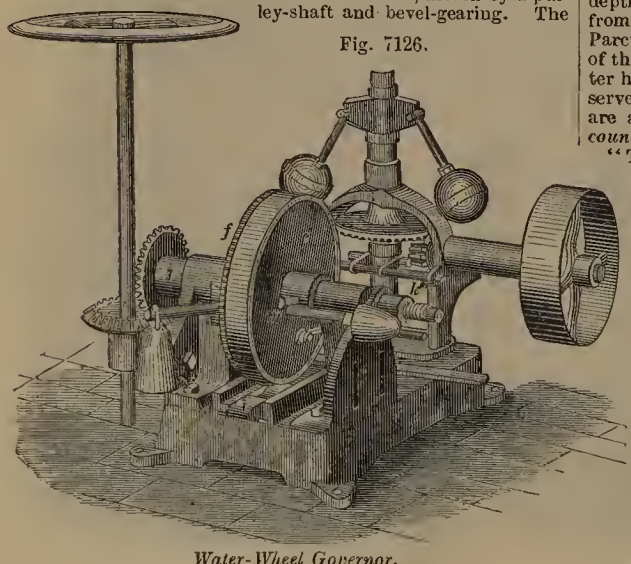
| | |
|---|---|
| Barker's mill. | Overshot wheel. |
| Bascule. | Persian wheel. |
| Bottom-discharge water-wheel. | Pitch-back wheel. |
| Breast-wheel. | Radial-piston water-wheel. |
| Bucket-wheel. | Reaction water-wheel. |
| Center-discharge wheel. | Scoop water-wheel. |
| Chapelet. | Screw-elevator. |
| Danaide. | Side-discharge water-wheel. |
| Double water-wheel. | Stream-wheel. |
| Downward-discharge wheel. | Turbine. |
| Flutter-wheel. | Tympanum. |
| Horizontal water-wheel. | Undershot water-wheel. |
| Inward-discharge wheel. | Ventilating water-wheel. |
| Noria. | Vortex water-wheel. |

**Wa'ter-wheel Gate.** One for limiting or determining the quantity of water to be allowed to flow into or on to the wheel, according to the power required.

**Wa'ter-wheel Gov'ern-or.** One to regulate the revolution of the wheel according to the machinery driven, so as to keep the rate uniform.

In the governor shown (Figs. 7126, 7127), *a* is the shaft which revolves the balls, driven by a pulley-shaft and bevel-gearing. The

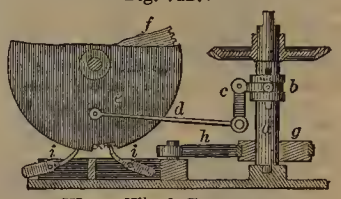
Fig. 7126.




*Water-Wheel Governor.*

rising or falling of the balls causes a vertical upward or downward movement of the collar *b*, which, through the medium of the bell-crank *c* and connecting-rod *d*, imparts a partial rotation to the shield *e*, which consists of a disk having a rim upon its edge, turned down at right angles and covering the toothed wheel *f*, but having a notch cut in its lower part. At each revolution of the ball-shaft *a*, the eccentric *g*, through the connecting-rod *h*, reciprocates a cross-head carrying the gravity-pawls *i i*. One or the other of these pawls engages the toothed wheel *f*, according as the notch in the rim of the shield permits the engagement. As the speed varies, the movement of the collar through the bell-crank and connecting-rod brings the notch in the shield in position to be engaged by one or the other of the pawls *i i*; when the notch is midway between the pawls, neither is brought into action. When the water-supply is less than the regulated amount, the notch is brought into such position that the proper pawl can enter and engage the wheel *f*, which is turned by the reciprocating motion of the connecting-rod *h* until the gate is lifted to the requisite hight through a bevel-wheel on the shaft *j* meshing with a bevel-wheel on the gate-shaft.

Fig. 7127.




*Water-Wheel Governor.*

By the turning of the wheel *f*, a nut *k* is moved upon the threaded end of *j*, until it abuts against a shoulder on the shaft and turns with it; at the same time, the pin *l* is brought under a lug *m* formed on the hub of the shield, which is thus turned until the notch is brought centrally between the pawls, when the acting pawl becomes disengaged, and farther raising of the gate is prevented. When the speed of the shafting to which the governor is belted is excessive, a reverse action takes place, and the other pawl acts to cause the lowering of the gate.

**Wa'ter-works.** The largest reservoir in the world was the Lake of Mœris, made by the Pharaoh of that name, and supplied by the flood-water of the Nile.

It has been explored by M. Linant, and found to be 150 square miles in extent, being retained by a bank 180 feet wide and 30 feet high, which can yet be traced for a distance of 13 miles. This reservoir was capable of irrigating 1,200 square miles of country.

The ancient city of Tlascala, in Mexico, was furnished with abundance of baths and fountains. Every house in Zempoloa had water. Tezcuco had an aqueduct from which every house was supplied by a pipe, as in modern cities. Cortez, in his first letter to Charles V., mentions the spring of Amileo, near Churubusco, of which the water was conveyed to the city of Mexico "in two large pipes, molded and hard as stone, but the waters never ran but in one at the same time." The Spaniards destroyed it, of course. Humboldt saw the remains of it, and says it was inferior to the aqueduct of Tezcuco.

The inca Garcilasso de la Vega was born in 1539 at Cusco, in Peru, about eight years after the Spanish invasion. His mother was a native princess, his father a Spaniard. He writes as follows of the Peruvian aqueducts: —

The seventh inca, Viracocha, "made an aqueduct 12 feet in depth and 120 leagues in length; the source or head of it arose from certain springs on the top of a high mountain between Parcu and Picuy, which was so plentiful that at the very head of the fountains they seemed to be rivers. This current of water had its course through all the country of the Rucanas, and served to water the pasturage of those uninhabited lands, which are about 18 leagues in breadth, *watering almost the whole country of Peru.*

"There is *another* AQUEDUCT much like this, which traverses the whole province of Cuntisuyu, running above 150 leagues from south to north. Its head, or original, is from the top of high mountains, the which waters falling into the plains of the Quechuas, greatly refresh their pasturage, when the heats of the summer and autumn have dried up the moisture of the earth."

These aqueducts "were carried over craggy rocks and inaccessible passages; and to make these ways plain, they had no help of instruments forged of steel or iron, such as pickaxes or sledges, but served themselves only with one stone to break another. Nor were they acquainted with the invention of arches, to convey the water on the level from one precipice to the other, but traced round the mountain until they found ways and passages at the same hight and level with the head of the springs.

"The cisterns or conservatories which they made for these waters, at the top of the mountain, were about twelve feet deep; the passage was broken through the rocks, and channels made of hewn stone, of about two yards long and about a yard high, which were cemented together, and rammed in with earth so hard that no water would

pass between to weaken or vent itself by the holes of the channel.

"The current of water which passes through all the division of Cuntisuyu, I have seen in the province of Quechua, which is part of that divisiou, and considered it au extraordinary work, and iudeed surpassing the description and report which hath been made of it. But the Spaniards, who were aliens and strangers, little regarded the convenience of these works, either to serve themselves in the use of them, or keep them in repair, nor yet to take so much notice of them as to mention them in their histories; but rather out of a scornful and disdaining humor, have suffered them to run into ruin beyond all recovery. The same fate hath befallen the AQUEDUCTS which the Indians made for watering their corn lands, of which two thirds at least are wholly destroyed and noue kept iu repair, unless some few which are so useful that without them they cannot sustain themselves with bread, nor with the necessary provisions of life. All which works are not so totally destroyed but that there still remain some ruins and appearauces of them."

The water supply of Rome during the first century of our era would suffice a population of 7,000,000, at the rate of the London supply. This, however, is very far from being suffieient for comfort or cleanliness. It was conveyed to Rome by nine aqueducts. (See AQUEDUCT.) Five more aqueducts were subsequently added. Three of the old aqueducts suffice for modern times. See AQUEDUCT, page 128.

The preseut London supply during July is 127,563,492 gallons of water to 3,645,069 persons, residing in 511,005 houses. The number of miles of streets eontaining mains eonstantly eharged, and upon which hydrants could at once be fixed, is 664½ miles, while the total number of hydrants erected thereon is at present 2,507.

The supply of various cities is reputed to be as follows: —

| | |
|---|---|
| Washington | 158 gallons daily to each person. |
| New York | 100 gallons daily to each person. |
| Brooklyn | 50 gallons daily to eaeh persou. |
| Philadelphia | 55 gallons daily to each person. |
| Baltimore | 40 gallons daily to each person. |
| Chieago | 75 gallons daily to each person. |
| Boston | 60 gallons daily to each person. |
| Cincinnati | 60 gallons daily to each person. |
| Albany | 80 gallons daily to each person. |
| Detroit | 83 gallous daily to each person. |
| Jersey City | 99 gallons daily to each person. |
| Buffalo | 61 gallons daily to each person. |
| Cleveland | 40 gallons daily to each person. |
| Columbus | 30 gallons daily to each person. |
| Montreal, Canada | 55 gallons daily to each person. |
| Toronto | 77 gallons daily to each person. |
| London, England | 29 gallons daily to each person. |
| Liverpool | 23 gallons daily to each person. |
| Glasgow | 50 gallons daily to each persou. |
| Edinburgh | 38 gallous daily to eaeh person. |
| Dublin | 25 gallons daily to each person. |
| Paris | 28 gallons daily to each person. |
| Turin | 22 gallons daily to each person. |
| Toulouse | 26 gallons daily to each person. |
| Lyons | 20 gallons daily to each person. |
| Leghorn | 30 gallons daily to each person. |
| Berlin | 20 gallons daily to each person. |
| Hamburg | 33 gallons daily to each person. |

The first water-works in the United States were planned and constructed by Mr. John Christopher Christensen, at Bethlehem, Pa., in 1762. The machinery consisted of three single-acting force-pumps, of 4-inch caliber and 18-inch stroke, and worked by a triple crank, and geared to the shaft of an undershot water-wheel, 18 feet in diameter, and 2 feet clear in the buckets. The water was raised by this machinery to the hight of 70 feet, and subsequeutly to 114 feet. The works were in operation as late as 1832. The first rising main was made of gum-wood, as far as it was subject to great pressure, and the rest was of pitch-pine. In 1789 leaden pipes were substituted, and in 1813 they were changed for iron.

The Corliss pumping-engine for the Providence Water-Works has a system of automatic self-regulation. The *table-engine* is capable of pumping 5,000,000 gallons of water per diem, or more, if needed. If all the outlets from the supply-pipes distributed over the service of the city are closed, so that no water escapes, the pumping apparatus remains perfectly at rest, but the instant auy appreciable outflow occurs, the machinery proceeds to supply the waste. It has been known to be over five and a half minutes in making a single revolution, moving regularly all this time, however, aud capable of automatically increasing the rate almost immediately to more than 30 revolutions a minute.

The "Holly" Water-Works in various cities of the Union have also an automatic regulator.

The first engine known to have been thus automatically regulated was one at Ross, Herefordshire, Englaud. In that town, in 1720, John Kyrle, celebrated in Pope's "Elegy" as the "Man of Ross," established a system of water supply for that town, which, from that time to the present, has been uninterruptedly in use. The distinctive feature of this system consists in forcing water by pumps into the street mains, so as to supply the town with water under such pressure as may be required. At the Ross works, the ordinary pressure for many years has been 45 pouuds per square inch. Steam-power has been substituted for the old water-wheels long since.

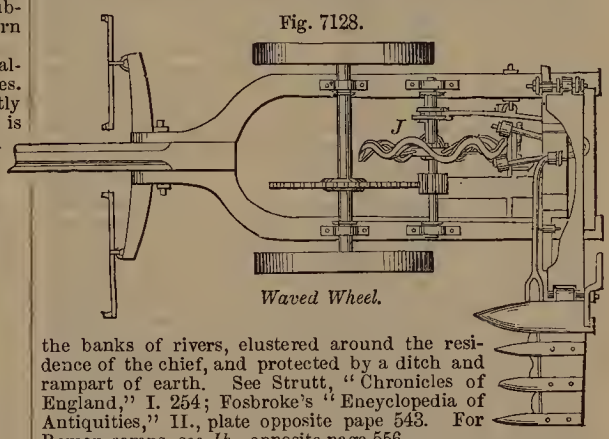
**Wat'tle.** A fence, panel, screen, or wall, made of withes interlaced with stakes. A very common device in Europe; not so usual here. See HURDLE.

Diodorus Siculus describes the houses of the Britons as being made of stakes wattled like hurdles, and thatched with reeds or straw. Strabo says the fashion was round, with a conical roof; Cæsar, that they resembled the houses of the Gauls, and were only lighted by the door. The Antonine Column, engraved in "Montfaucon's Supplement," III. v. 2, e. 8, and "British Monachism," page 274, shows them cylindrical, with dome-shaped or truncated conical roofs, with a central hole at the apex for a chimney.

Round houses of stone, with thatched roofs bound with straw ropes, are yet used in the Scilly Isles, the outlying lands of the Cornwall peninsula, the rough corner where the cymric autochthenes were allowed to exist when the storm of Saxon massacre swept over the land. See Woodley's "Scilly," page 165.

The wattled huts of the Britons were grouped in forests or on the banks of rivers, clustered around the residence of the chief, and protected by a ditch and rampart of earth. See Strutt, "Chronicles of England," I. 254; Fosbroke's "Encyclopedia of Antiquities," II., plate opposite pape 543. For Roman camps, see *Ib.*, opposite page 556.

Fig. 7128.




*Waved Wheel.*

"The walls of the church [First Abbey Church of Glastenbury, England], according to Malmesbury, were made of twigs, winded aud twisted together, after the antient custome, that King's palaces were used to be built. So the King of Wales, by name Heolus Wha, in the year of our Lord 940, built a house of white twigs, to retire into when he came a hunting into South Wales; therefore it was called *Ty Gwyn*, that is, the *White house*. For to the end that it might be distinguished from vulgar buildings, he caused the twigs (according to his princely quality) to be barkt; nay castles themselves, in those daies, were framed of the same materials and weaved together; for thus writes Giraldus Cambrensis, of Pembroke castle, (saith he) 'Arnulphus de Montgomery in the daies of King Henry the first built that small castle of twigs and slight turf.'" — SAMMES.

Wattled chimneys still occur in Wales; the stick chimneys, so common in the early log-cabins of our country, are very similar. The doors of the British houses were of wattled twigs and clay. Some wattled houses yet remain in Montgomeryshire, Wales; rced houses are yet found in Ireland. Dartmoor, England, has numerous remains of circular stone foundations of these ancient houses of turf or wattles: —

*Junctæ cortice virgæ.* — OVID.

These circles have doorways facing the south, and have diameters from 12 to 30 feet. See Fosbroke's "Encyclopedia," *ut supra*, Vol. I. pages 99 - 101.

**Waved Wheel.** The edge of the wheel is waved or convoluted, so that as it revolves it imparts a lateral oscillation to an arm, pitman, or what not. An anti-friction roller at the end of the arm traverses the face of the wheel, following its prominences and depressions. The cut (Fig. 7128) shows its application to a mower.

**Wave-pow'er.** Numerous attempts have been made to utilize in driving machinery the power of the waves.

Dr. Scoresby gives the following interesting facts with regard to the length and hight of ocean waves. The mean hight of waves in the Atlantic, driven by a westerly gale, is 18 feet. The greatest recorded hight of a wave in the North Atlantic, from the trough to the crest, is 43 feet. In northwest gales, waves 40 feet in hight have been measured off the Cape of Good Hope, while those off Cape Horn were 32 feet. The velocity of ocean storm-waves in the North Atlantic is about 32 miles an hour, and that recorded by Captain Wilkes for the Pacific Ocean

is 26½ miles. In an Atlantic storm the breadth of the waves, measured from crest to crest, is about 600 feet.

Some sixty years since a cotton-mill was built on a rocking barge, the machinery to be moved by the force of the waves.

See Buckner's patent, May 16, 1873.

One patent of March 30, 1869, has a reservoir which is filled by the waves dashing up a curved barrier wall, and the water thus raised beyond its normal hight is caused to drive a mill, and discharged at the retreat of the waves or the ebb of the tide.

See also TIDE-WHEEL; TIDE-MOTOR.

Straho speaks of several earthquake-waves: one at an early period, recorded by Timæus, in the country of Campania.

"Helice in Achaia was overwhelmed by an earthquake-wave two years before the battle of Leuctra [373 B. C.]. Eratosthenes himself says that he saw the place."—STRABO. The disaster occurred at night; the town was 12 stadia (12 × 202½ yards) from the sea. The territory was divided among the neighboring people.

At Arica, the seaport of Arequipa, about twenty minutes after the first shock, all of which lasted but a few minutes, the sea was observed suddenly to recede and immediately afterward a wall of water, estimated to be 50 feet in hight, was seen advancing. This overwhelmed a large portion of the town, carrying with it the United States steamer Wateree and a Peruvian corvette, which had been anchored before the town, and were landed high and dry half a mile to the northward. At Chala three such waves swept in, the sea passing more than half a mile beyond its usual limits. At Islay there were no less than five such waves, each of increasing force, and an hour and a half after their commencement the waves still ran to a hight of forty feet above their usual level. At Iquique, a single wave some 50 feet in hight, after submerging an island lying in front of the town, and rushing far inland, soon resumed its usual condition.

Similar effects have been frequently noted in connection with earthquakes. Among the most remarkable was that which occurred at the great earthquake in 1755, so destructive at Lisbon, where an immense wall of water many feet in hight was observed to come rolling inward from the Atlantic, breaking with irresistible force upon the shore and carrying everything before it. The frequent earthquakes which have devastated the Pacific coast of South America, lying at the base of the Peruvian and Chilian Andes, have been accompanied by the same phenomenon. These waves, far exceeding in hight the ordinary waves of the sea, and still more the great tidal wave which twice each day makes the circuit of the globe, have twice totally destroyed the town of Callao with the greater part of its inhabitants, carrying ships far inland. None, however, have probably equalled in their hight, or in the extent for which they have been traced over the earth's surface, that which accompanied the terrible earthquake at Arequipa a few minutes after 5 P. M., on the 13th of August, 1868.

At Callao the waters retreated considerably, but the return flow was much less severe in its effects. Irregular movements of the sea, however, continued for several days.

In less than three hours after the occurrence of the earthquake the effects of this wave were experienced at Coquimbo, 800 miles south of Arica, and in about an hour it had reached Constitucion, 450 miles still farther to the southward.

At San Pedro in Southern California, nearly 5,000 miles from Arica, a few hours after the occurrence of the earthquake the sea rose upward of 60 feet above its ordinary level.

At the Sandwich Islands, over 6,000 miles distant, in the night between the 13th and 14th, the sea suddenly rose with such violence as to inundate some of the smaller islands, and its oscillations were observable for three days.

At Yokohama, Japan, more than 10,500 miles from Arica, an enormous wave poured in on the 14th of August; the hour is not given.

In the South Pacific the wave reached the Marquesas and adjacent groups shortly before midnight; some were entirely submerged. It approached the Samoa or Navigator's Islands about half past two in the morning of the 14th, and the sea, after rising to an unprecedented hight, more gradually sank; this alternate rising and falling continued for several days. New Zealand was reached about an hour later; here the water gradually receded, until at Port Littleton the whole harbor was left dry and continued so for some twenty minutes; the water then returned in a perpendicular wave, 10 or 12 feet high. About five the water retreated very slowly as before, reaching its lowest stage about six, to be succeeded an hour later by a wave similar to the first. There were four of these oscillations in all, occurring at intervals of about two hours. These disturbances, though less considerable, continued until the 17th. At hours varying from 6½ in the morning to noon the great wave had reached different points on the eastern and southern shores of Australia; but here its effects were less decided. It has been calculated that its total length could not have been less than 8,000 miles, the width varying from 200 to 1,000 miles. The length of the region where the direct effects of the earthquake were perceived is estimated at 240 miles.

**Wave-trap.** (*Hydraulic Engineering.*) A widening inward of the sides of piers, to afford space for storm-waves which roll in at the entrance to spread and extend themselves.

**Wax.** A fatty, solid substance secreted by bees. Also, some vegetable exudations, resembling true wax in qualities or appearance. See SEALING-WAX; GRAFTING-WAX; etc.

For bleaching, see patent No. 38,540.

**Waxed-end.** A shoemaker's sewing-thread with a bristle ingeniously fastened at the end, to enable it to lead through the hole made by the awl.

See patents, Nos.

134,998. Preparing wax-ends.
9,817. Machine for twisting wax-ends.
73,270. Machine for twisting wax-ends.

**Wax'er.** An attachment to a leather sewing-machine to wax the thread as it runs from the spool to the needle.

**Wax'ing.** 1. (*Leather-manufacture.*) The process of finishing leather which has been *shaved*, *daubed*, *grained*, *bruised*, and *whitened*. It consists of treating with *blacking* (oil, lampblack, and tallow), *black size* (stiff size and tallow), and subsequent treatment with a *slicker*.

2. The treatment of thread with soft wax in the sewing-machine for boots and shoes.

3. The process of stopping-out colors in calico-printing.

**Wax-match Ma-chine'.**

A machine for preparing wax-coated matches for dipping was invented and exhibited at the Paris Exposition, by Mr. Mujica of St. Sebastian, Spain. The lengths are cut by the machine, which arranges them, all the matches of each layer being cut simultaneously by one action of the knife. The material, which is flexible, being a cotton wick covered with wax, is placed in the machine in coils. From these coils, or bobbins, seventy-two little waxen cylinders are carried forward by the rotation of a pair of feeding rollers, and at the proper moment the knife cuts them, and the matches thus cut off rest upon a receiving plate covered with flannel. For the rest, the operation is essentially the same as that described above. The frame is depressed in this case by means of a screw, and a second plate is placed on the row of matches which has just been deposited. The frame will hold 4,000 or more matches, which are secured and dipped as above described. The whole operation occupies from five to eight minutes. A single workman may prepare and finish with this machine as many as 400,000 matches a day.

**Wax-mod'el-ing.** Wax was formerly much used by sculptors in forming their models, particularly for hollow castings. The process, however, has been generally superseded by that of clay and sand modeling, though wax is still employed by silversmiths. See STATUARY CASTING.

Founder's wax was commonly mixed with tallow, turpentine, and pitch, in the proportion of about ten of wax to one of each of the other ingredients. When the safe-mold from the model was completed it was filled in to a certain thickness with wax, and the interior was filled with a fire-proof composition of plaster and brick-dust to form a core. The mold was then removed, and the wax, after being carefully revised by the sculptor, was covered with a fire-proof mold composed of plaster, brick-dust, cow-hair, and horse-dung, laid on in layers with a brush. When sufficiently thick, the whole being properly supported and vents being made, a coal-fire was kindled around it and all the wax burned out. The mold was then bricked up, the pit filled with sand, and the metal being poured in took the place of the wax.

A simple mode of forming the wax shell is to immerse the mold, while the wax is yet fluid, into cold water; this hardens the wax superficially; the interior fluid part is then drawn off.

In the so-called *ceroplastic* art the objects, such as images, fruits, flowers, anatomical models, etc., are cast in the wax itself. The molds are composed of plaster of paris, or a composition of beeswax, burgundy pitch, and venice turpentine, with a very little olive-oil. This composition is elastic, and when thin can be peeled off the cast.

A cheap method adopted with waxen figures is to mold the face in paper pulp and size, paint it in strong colors, and apply two or three coats of fine wax through which the colors show. The eyes and hair can then be added. Local effects can be modified by painting with wax and turpentine.

**Way.** (*Shipwrighting.*) *a.* The timber sills upon which a ship is built, and upon which she slides in launching.

*b.* The inclined sills or track upon which a ship slides when being drawn up out of the water. See SLIP.

**Way-end.** (*Mining.*) A term applied in iron-stone mines to that part of the face where the road enters.

**Way-gate.** The tail-race of a mill.

**Ways.** Balks or skids for rolling up weights or for sliding them down.

*Launching-ways* support the cradle of a ship, and form the track on which it descends into the water.

The great ship of Ptolemy Philopator was built on ways; Callixenus, in his "Account of Alexandria," quoted by Athenæus in his "Deipnosophists," V. 37, says: —

"The vessel was launched originally from a sort of framework which they say was erected and made out of the wood of 50 ships of 5 ranks of oars."

**Way-shaft.** (*Steam-engine.*) A shaft in a lever-beam engine which actuates the slide-valve. See LEVER-ENGINE.

**Way-wis'er.** A somewhat fanciful name for the *pedometer*, *perambulator*, or ODOMETER. See the latter.

**Weap'ons and Ac-cou'ter-ments.** See under the following heads: —

Accelerator.
Accouterments.
Air-gun.
Ammunition.
Angel-shot.
Arbalest.
Armor.
Arms.
Armstrong-gun.
Arquebus.
Arrow.
Artillery.
Assegai.
Back-sight.
Back-sword.
Ball.
Ball-cartridge.
Ballista.
Ballistic pendulum.
Ball-screw.
Bar-shot.
Battering-ram.
Battery.
Battery-forge.
Battery-gun.
Battery-wagon.
Battle-axe.
Bayonet.
Bayonet-scabbard frog.
Bilbo.
Bill.
Bird-bolt.
Birding-piece.
Blank cartridge.
Blow-pipe for blow-gun.
Blunderbuss.
Boarding-pike.
Bolas.
Bomb.
Bombard.
Bomb-chest.
Bomb for killing whales.
Bomb-lance.
Bomb-shell.
Boomerang.
Bow.
Bowie-knife.
Brake.
Breech-loader.
Breech-sight.
Broadsword.
Buckshot.
Bridge-barrel.
Bullet.
Bullet-mold.
Bullet-screw.
Bullet-shell.
Burrel-shot.
Caisson.
Cane-gun.
Canister-shot.
Cannon.
Cannon-ball.
Cannon royal.
Cap. Percussion.
Carbine.
Carcass.
Carronade.
Carthoun.
Cartouch.
Cartouch-box.
Cartridge.
Cartridge-bag.
Cartridge-belt.
Cartridge-box.
Cartridge-retractor.
Casemate-gun.
Case-shot.
Catapult.
Cavalot.
Centrifugal gun.
Chain-shot.
Charge.
Charger.
Chassepot-gun.
Chassis.
Chronograph.
Chronoscope.
Cimeter.
Claymore.
Cochorn.
Columbiad.
Combination fuse.
Congreve-rocket.
Cross-bar shot.
Cross-bow.
Cuirass.
Cuisse.
Culverin.
Curtal-axe.
Cutlass.
Dagger.
Dahlgren-gun.
Dart.
Dirk.
Double-barreled gun.
Double-headed shot.
Enfield rifle.
Eprouvette.
Falchion.
Field-gun.
Fire-arm.
Fire-ball.
Fire-lock.
Fish-gig.
Flint.
Flint-lock.
Flying-artillery.
Foil.
Fowling-piece.
Friction-primer.
Friction-tube
Fuse.
Fuse-lock.
Fusil.
Gatling-gun.
Gauntlet.
Gingal.
Gis-arm.
Glave.
Grape-shot.
Greek-fire.
Grenade.
Gun.
Gun-barrel.
Gun-carriage.
Gun-cotton.
Gun-harpoon.
Gun-lock.
Gunner's calipers.
Gunner's level.
Gunner's perpendicular.
Gunner's quadrant.
Gun-pendulum.
Gunpowder.
Gun-stock.
Gun-tackle.
Hair-trigger.
Halberd.
Hammer.
Hand-grenade.
Hanger.
Harping-iron.
Harpoon.
Haversack.
Helmet.
Howitzer.
Incendiary compounds.
Incendiary shell.
Javelin.
Jingal.
Junk-wad.
Knapsack.
Ladle
Lancaster-gun.
Lance.
Langrel.
Lasso.
Leister.
Level. Gun
Light ball.
Limber
Linstock.
Lock-gun.
Long-bow.
Lubricator.
Mace.
Madrier.
Magaziue-arm.
Malkin.
Martel-de-fer.
Martin's shell.
Match.
Match-lock.
Merkin.
Metallic cartridge.
Minie-ball.
Mitrailleur.
Morning-star.
Mortar.
Musket.
Musketoon.
Muzzle-sight.
Nail-ball.
Needle-gun.
Nipple.
Onager.
Ordnance.
Ordnance-operating.
Paixhan.
Parrot-gun.
Pass-box.
Pendulum-hausse.
Percussion cap.
Percussion-fuse.
Percussion-shell.
Petard.
Pike.
Pistol.
Pistol-carbine.
Pivot-gun.
Pointing-wire.
Poniard.
Port-fire.
Pot-gun.
Powder-flask.
Powder-hose.
Primer.
Primiug-tube.
Priming-wire.
Pritch.
Projectiles. See List.
Prolonge.
Proof.
Quick-match.
Quiver.
Quoin.
Rammer.
Ramrod.
Rapier.
Repeating fire-arm.
Retractor.
Revolver.
Ribadoquin.
Rifle
Rifling.
Rocket.
Rocket-harpoon.
Round-shot.
Saber.
Saber-bayonet.
Sabot.
Saker.
Salamander.
Sand-shot.
Scabbard.
Scimeter.
Segment-shell.
Shell.
Shield.
Shot.
Shot-cartridge.
Shot-gun.
Shot-pouch.
Shrapnel.
Shunt-gun.
Siege-gun.
Sight. Gun
Signal-rocket.
Sling.
Slow-match.
Slug.
Small-arm.
Smoke-ball.
Spear.
Spherical case-shot.
Sponge.
Stanchion-gun.
Steam-gun.
Stiletto.
Stock-fowler.
Stretcher.
Sumpit.
Swab.
Swivel-gun.
Sword.
Tangent-scale.
Tape-primer.
Thumbstall.
Time-fuse.
Tinker.
Tomahawk.
Tompion.
Torpedo.
Traverse-circle.
Tube. Priming
Tumbler-punch.
Twist.
Vent-stopper.
Wad.
Wad-mill tilt.
Wad-punch.
Whip.
Whitworth-gun.
Wiper.
Wire-cartridge.
Worm.

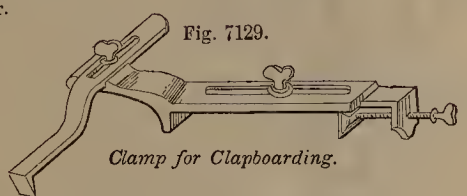


Fig. 7129.

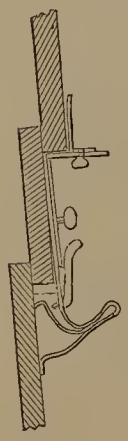
*Clamp for Clapboarding.*

**Weath'er.** (*Nautical.*) The side of the vessel exposed to the wind; in contradistinction to the *lee* or *leeward* side, which is away from the wind.

**Weath'er-board.** Lapping siding-boards for houses.

**Weath'er-board'ing Clamp.** One for holding the board against the studding while nailing. The device is clamped to the corner board or sash-facing of the house, and the adjustable claw-arm supports one end of the board.

Fig. 7130.



*Clapboard-Gage.*

**Weath'er-board'ing Gage.** One for spacing and holding the boards at a gaged distance apart while being nailed.

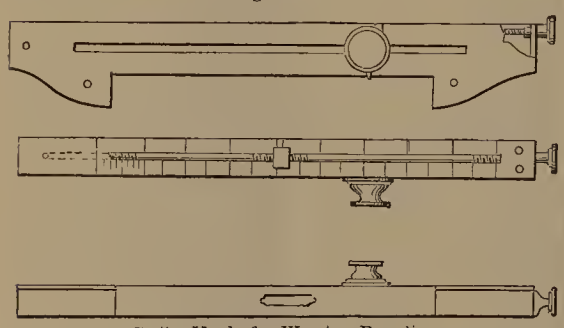
The fixed dog takes under the edge of a board, and the spriug-dog is depressed by a lever to engage the face of a board below and give support to a board above.

Fig. 7131 is not for holdiug, but is for making the scribe-mark for the lower edge of the uext board. The adjustable scribe is used for markiug the weather-boarding. The slide-gage is used for spacing, is set to the scale, aud is adjusted by a longitudinal screw-rod turned by a knob at the eud. The spur is used to denote the place for the uext gage-uail.

**Weath'er-board'ing Saw.** A machine for cutting logs into feather-edge boards for weather-boarding.

It is a circular saw which cuts kerfs the length of the log from the bark toward the heart the depth beiug that required for the width of the boards, after which another rank of boards is cut off, if the size of the log permit. See "Holtzapffel," II. 797, Fig. 790.

Fig. 7131.



*Scribe-Hook for Weather-Boarding.*

**Weath'er-cock.** A vane, turned by the wind to show the direction thereof.

A brazen triton holding a rod in his hands was a common figure in Greece and Rome. In Constantinople, a female figure was placed on the summit of a brazen obelisk, and turned by the impulse of the wind; it was called the *handmaid of the winds*. An anemoscope near the Appian Way had a round table of stone divided and inscribed with the names of the twelve winds. The cock became a favorite form of vane, as an emblem of vigilance, and hence the name *weathercock*.

Fig. 7132.

*Weather-Prophet.*

**Weath'er-glass.** An instrument for indicating coming changes in the weather.

A *barometer*, or a *hygrometer*. One acts by the varying *weight* of the atmosphere; the latter by changes in its *wetness*.

The sympiesometer is a form of barometer.

"Walked to Greatorex's, and have bespoke a weather-glasse of him." — PEPYS's *Diary*, 1662.

**Weath'er-ing.** The angle at which the sails of a windmill are set.

**Weath'er-proph'et.** A *hygrometer*. Usually certain mechanical results from the weight or flexure of materials, due to dampness, are made to move a figure or pair of figures, — a man and a woman on a poised arm, for instance, so that the former advances from his porch in wet, the lady in dry weather.

In Fig. 7132, the seed of a geranium, which is found to coil itself up by the action of moisture, and uncoil when dry, is connected with a shaft, upon which is balanced a delicate diminutive umbrella, so that in moist weather the umbrella shall be raised up over the head of a little figure of a man, to which the shaft is attached, and fall down to a horizontal position when the weather is dry. See also HYGROMETER.

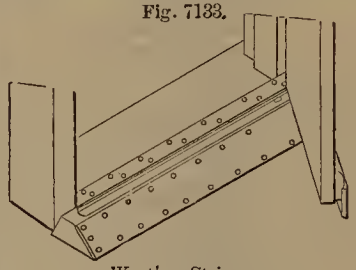
**Weath'er-strip.** A pliable piece of rubber, for instance, which closes accurately the space between the shut door and the threshold.

Or a jointed piece which lifts clear when the door is opened, and shuts tightly down when the door is closed.

In Fig. 7133, a flexible strip, attached to the bottom of the door, occupies, when the door is closed, a metallic trough which carries the water away.

In Fig. 7134, the leaf is attached by an elastic strip to the cleat on the door. The hinging portion admits of the depression of the leaf, and, by its resiliency, acts as a spring to raise it when the door is open.

Fig. 7133.



*Weather-Strip.*

Fig. 7134.

*Weather-Strip.*

**Weath'er-til'ing.** That placed in vertical position on the side of a house.

**Weav'ing.** See LOOM.

Fig. 7135 is from an illuminated MS. of the "Boccace des Nobles Femmes," and illustrates the story of Cyrille, the wife of King Tarquin. One lady cards the wool, another spins it, using a distaff and whorl; the queen weaves.

Fig. 7135.

*A Queen and her Maids at Work.*

See under the following heads: —

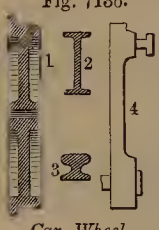
Abb.
Bar-loom.
Barrel-loom.
Basket-weaving loom.
Batten.
Bead-loom.
Beam.
Beaming.
Belting-weaving loom.
Bier.
Blind-weaving loom.
Bobbin for shuttle.
Bottle-case loom.
Braiding-machine.
Brussels-carpet loom.
Button-loom.
Caam.
Card.
Carpet-loom.
Case.
Chain.
Circular loom.
Circular shuttle-box loom.
Compass-board.
Corded-fabric loom.
Cording.
Counterpane-loom.
Couper.
Crinoline-loom.
Cross-weaving loom.
Cross-shed.
Curvilinear-weaving loom.
Cut-piled fabric-loom.
Cut-mark.
Cuttee.
Damask-loom.
Double-cloth loom.
Double-piled fabric-loom.
Draft.
Drawing-in.
Draw-loom.
Driver.
Drop-box.
Elastic-fabric loom.

Electric loom.
End.
Fell.
Figured-fabric loom.
Figure-weaving.
Filling.
Flaw.
Floating.
Flushing.
Fly-shuttle.
Fringe-loom.
Gauze-loom.
Haircloth-loom.
Hand-loom.
Harness.
Harness-motion.
Heald.
Heck.
Heck-box.
Heddle.
Horsehair-loom.
Hose-loom.
Ingrain-carpet loom.
Jacquard-loom.
Lash.
Lathe.
Lay.
Lay-race.
Leaf.
Lea-rod.
Lease.
Lease-rod.
Leash.
Let-off.
Loom.
Loom-card.
Loom-harness.
Loom-shuttle.
Mail.
Matting-loom.
Metallic-tissue loom.
Narrow-fabric loom.
Palmleaf loom.
Pattern-box.
Pattern-card.
Pattern-chain.
Pattern-cylinder.
Picker.
Picker-staff.
Picking-peg.
Piled-fabric loom.
Pile-weaving.
Pile-wire.
Pirn.
Positive-motion loom.
Power-loom.
Race.
Raddle.
Ravel.
Reed.
Ribbon-loom.
Rocking-tree.
Satin-loom.
Scarf-loom.
Shaped-fabric loom.
Shawl-loom.
Shed.
Shell.
Shoot.
Shot.
Shuttle.
Shuttle-box.
Shuttle-check.
Shuttle-winder.
Sieve-cloth loom.
Silk-loom.
Simblot.
Simple.
Sley.
Split.
Stop-motion.
Straw-fabric loom.
Stripe.
Swivel-loom.
Sword.
Table.
Take-up.
Tanty.
Temple.
Templet.
Terry-fabric.
Thrum.
Travers.
Trevat.
Tubular-fabric loom.
Twill.
Twist.
Two or three ply carpet-loom.
Velvet-loom.
Warp.
Warp-beam.
Warp-dresser.
Warping-jack.
Warping-mill.
Weft.
Weft-fork.
Weft-hook.
Wire-weaving loom.
Woof.

**Web.** 1. Woven fabric.

2. *a.* The plate, or its equivalent, in a beam or girder which connects the upper and lower flat plates or laterally extending portions (2, Fig. 7136).

Fig. 7136.




*Car-Wheel.*

*b.* The corresponding portion, between the *tread* and *foot* of a railway-rail (3).

3. That portion of a car-wheel which extends between the *hub* and the *rim* (1).

4. The blade of a saw.

5. (*Vehicle.*) Stout bands of textile fabric, used as straps to limit the extension of the hood. See also WEBBING.

6. (*Anvil.*) That portion of an ordinary anvil which is of reduced size below the *head*, and from which the divergent horns proceed.

7. The *arm* of a crank, connecting the *shaft* and the wrist (4).

8. The *bit* of a key consists of the *web* and the *wards*. The latter are the slots which are traversed by the wards of the lock as the key turns. See KEY.

**Web'bing.** (*Saddlery.*) 1. Canvas employed in the lining of a saddle.

2. A woven band of cotton or flax, generally striped, and used for reins, girths, straining-pieces of saddles, surcingles, bed-bottoms, etc.

**Web Print'ing-ma-chine'.** A printing-machine which takes its paper from the web or roll.

The *web-press* is a late improvement, and bids fair to supersede all others for large editions and long numbers where great nicety is not required. It is not yet expected that for fine book-work and cuts it will supersede the flat-bed presses.

The Walter press is described and illustrated at page 1667, Fig. 3641.

The Bullock press at page 1667, Figs. 3642, 3643.

The "Victory," page 1797, Fig. 3951.

The Campbell is running on a Jersey City newspaper, but is not illustrated in this book, not having been received in time.

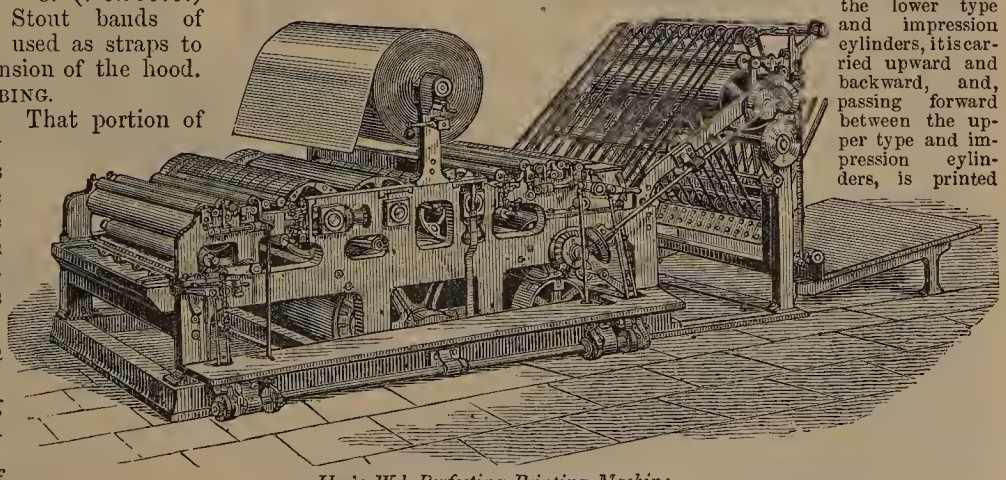
In the Hoe web perfecting-press (Fig. 7137), the paper is printed from a roll containing a length of over four miles and a half, — equal to 10,000 papers. The machine has three pairs of cylinders geared together. A roll, having been previously damped, is lifted into place by a small crane, and the paper from it passes between the first pair of cylinders, the circumferences of each of which are just equal to the required length of the sheet. One of these cylinders has its periphery covered with stereotype plates of the matter to be printed, and is supplied in the usual manner with an ink fountain and distributing rollers, which, as the cylinder revolves, apply the ink to the stereotype form. The other cylinder is covered with blanket, and as they revolve together with the paper between them they print its first side. The paper then passes on between the second pair of cylinders, and presents its blank side to the stereotype plates of the second type-cylinder. The paper then passes onward to the cutting-cylinders, on the periphery of one of which is a projecting knife, that, as they revolve, enters into a narrow groove in the opposite cylinder, and thus at each revolution severs a sheet from the roll. These sheets are successively conveyed by two series of endless tapes to a revolving cylinder, which retains them until six (or any desired number) are collected upon it, when they are delivered in a body to the sheet-flyer. A circular cutter cuts the double sheets into single copies. A counter is attached which shows the number of sheets printed. The machine occupies a space of about 20 feet long, 6 feet wide, and 7 feet high.

These machines have a reputation on both sides of the Atlantic, being used by the London "Lloyd's News," "Standard," and "Telegraph," while several of them are now used in newspaper offices in the United States.

The latest form of this press was exhibited in the Machinery Hall, Centennial grounds, having an automatic folding attachment and deliveries on each of four banks, at the rate of 7,500 each, a total of 30,000 per hour of the Philadelphia "Times," equal to 15,000 of a paper of the size of the New York "Tribune," for instance.

Fig. 7138 illustrates a web perfecting-press, made at Augsburg. The paper passes first through damping-rollers, adjustable to give any required degree of wetness, then through adjustable tension-rollers to the first type-cylinder, which is the lowest in the vertical series of four, seen in the cut; the two central ones are the impression-cylinders, and the upper one the second type-cylinder.

Fig. 7137.



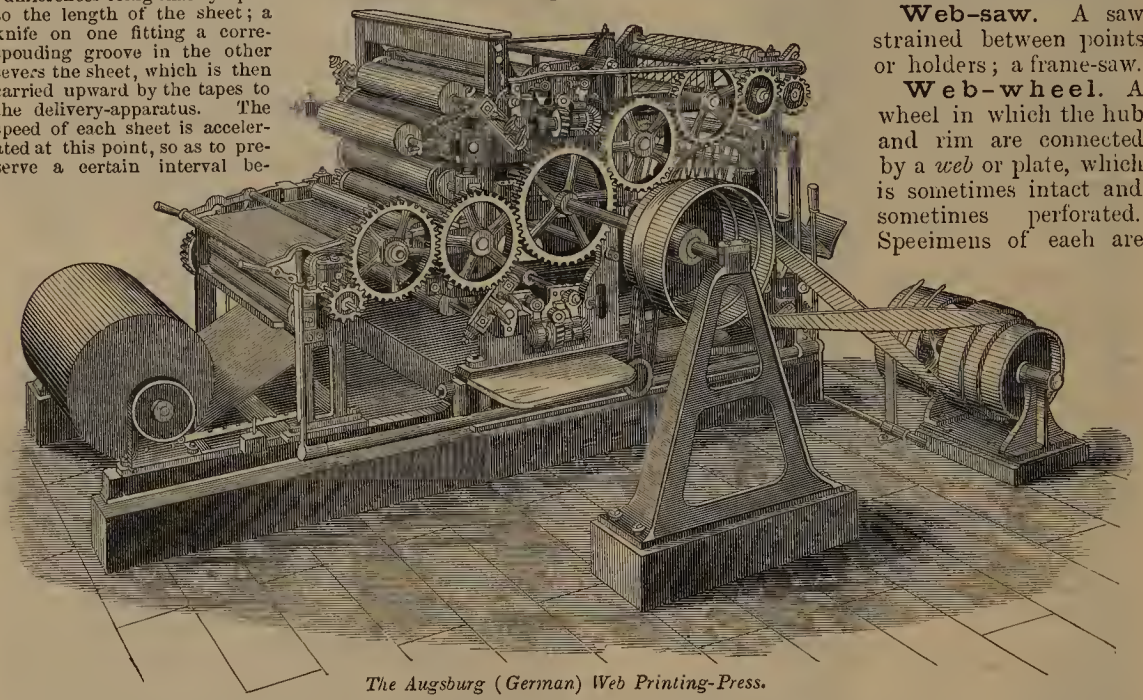
*Hoe's Web Perfecting Printing-Machine.*

Receiving an impression between the lower type and impression cylinders, it is carried upward and backward, and, passing forward between the upper type and impression cylinders, is printed

on the other side. These four cylinders are all exactly of the same size, producing a perfect register. The paper now passes horizontally forward to the cutting-cyliuders, which are on the same level as the two upper printing-cylinders, and of the same diameter, their circumferences being exactly equal to the length of the sheet; a knife on one fitting a corresponding groove in the other severs the sheet, which is then carried upward by the tapes to the delivery-apparatus. The speed of each sheet is accelerated at this point, so as to preserve a certain interval between them. The delivery is to the right and left alternately. An iudex registers the number of copies printed as they are cut off.

The Campbell perfecting-press is also a two-impression and two-printing roller-machine, with automatic folder.

Fig. 7138.



*The Augsburg (German) Web Printing-Press.*

**Web-saw.** A saw strained between points or holders; a frame-saw.

**Web-wheel.** A wheel in which the hub and rim are connected by a *web* or plate, which is sometimes intact and sometimes perforated. Specimens of each are to be found among car-wheels. The term is applied in contradistinction to one with spokes. Clock and watch wheels are cast or stamped with webs and then *crossed out;* the web being perforated and filed till it assumes the form of a cross, having four spokes.

**Wed'ding-knot.** (*Nautical.*) A tie for uniting the looped ends of two ropes.

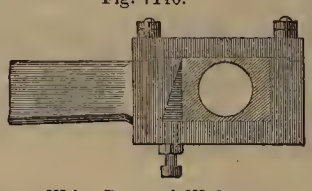
Fig. 7139.

*Wedding-Knot.*

*a b*, eyelets.
*c d*, the *join.*
*e*, the fastening.

**Wedge.** The uses of wedges for splitting timber or stone, for driving up tenons or the parts of scarf-joints, are familiar, and are noticed in their connection with these and other operations.

Fig. 7140.



*Wrist-Box and Wedges.*

The iron wedge is the *cugnus* of the Middle Ages. The ancient wedges were of holm, laurel, or elm. A Roman wedge found in Wales had a square perforation through which a handle was thrust to hold it, while it was being driven by a maul.

The mining-wedge is known as a *gad.* See Fig. 2140, page 932.

Wedges for some purposes are made by machinery. See patents 121,264 and 119,306 of 1871.

Some machines for splitting firewood have a gang of wedges.

The invention of the wedge is ascribed by the Greeks to Dædalus of Athens, about 1240 B. C. Its character, however, is such that it is futile to attempt to date the time at which a tapering block was first driven into a cavity to split open a fissure. The largest of the Pyramids were built several hundred years before Dædalus, and perhaps about the time of Cecrops. The size of the blocks makes it certain that at some time in the quarrying, transportation, and depositing in place, the wedge and lever were freely used.

Fig. 7140 illustrates the use of a wedge for tightening up the box by which a shaft is secured to a crank, and for similar purposes. The bearing in each half of the box is originally made to constitute rather less than half a semicircle. The two halves do not meet, but one is advanced toward the other by turning a screw which acts on the wedge as the bearings become worn.

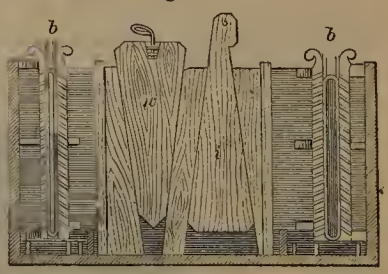
**Wedge-cut'ter.** A form of cutting-pliers used by dentists for cutting wooden wedges by which teeth are pried apart.

**Wedge-press.** A form of press, more used in Europe and formerly than now, for expressing oil from crushed seeds, such as those of flax, nuts, poppy, hemp, olive, almond, mustard, sunflower, rape, colza, castor, cocoa, cotton, etc., etc.

A screw-press has been substituted for the wedge-press in the expression of some of the above oils, but the great dependence now is upon the hydraulic press, which is more convenient, compact (according to duty performed), and powerful than any other press.

In the wedge-press, the hair-bags *b* containing the crushed seeds are placed between perforated iron cheek-plates, which allow the expressed oil to escape downward to the cistern below, whence it passes off by an opening. The space between the bags and their enveloping plates is occupied by blocks and wedges. The tightening-wedge *w* is driven by a maul or a vertical stamper, operated by a wiper-wheel, and is considered to be tight enough when the stamper makes three rebounds from it, after a blow. Time being allowed for the oil to exude, the wedges and blocks are loosened by blows upon the inverted wedge *i*. The bags being removed, others are substituted, and the contents of the bags which have been subjected to pressure are removed for farther treatment.

Fig. 7141.




*Wedge-Press.*

If it be the first time they have been subjected to pressure, the oil is cold-drawn and of the best quality. The meal is then subjected to the action of stampers, and another body of oil, the second quality, is expressed therefrom. The magma is

then heated, and a third quality expressed. An inferior quality may be obtained after boiling the ground cake in water. After the third expression, the cake is suitable for cattle feed. After the fourth, it is used for manure.

See Perkins's patent, August 30, 1832.

**Wedg'ing.** (*Pottery.*) The process of dividing a lump of clay and dashing the parts together in a direction different from its former contact. It brings the mass to a homogeneous condition, develops plasticity, and expels air-bubbles.

**Wedg'wood-ware.** (*Pottery.*) A kind of semi-vitrified ware without a superficial glaze, and named after the inventor, Josiah Wedgwood. See POTTERY.

Several other kinds were introduced by Wedgwood.

1. Queens-ware or cream-colored ware, made by combining metallic oxides with pipe-clay and sand.
2. Terra-cotta; a ware in imitation of porphyry, granite, and other kinds of hard stone.
3. Basalt; a very hard black ware.
4. Porcelain-biscuit; differing from the above chiefly in being of a white color.
5. Bamboo-ware; a kind of cane-colored biscuit.
6. Jasper; a delicate white biscuit, suitable for cameos and statuettes.

**Weed'ing-hoe.** See HOE.

**Weft.** The *filling* or *woof* of a *web;* running from selvage to selvage. Also known as the *shoot*, or *tram*.

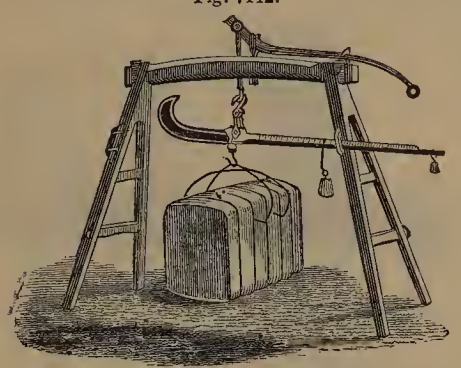
**Weft-fork.** (*Weaving.*) *a.* One used in certain kinds of looms where the filling is laid in, one piece at a time. See SLAT-WEAVING LOOM.

*b.* An arrangement for stopping the loom if the weft-thread should break or fail. The original *stop-motion*.

It was invented by James Bullough. English patent enrolled July 14, 1841.

"In the end of the reed three or more wires are inserted, and when the stay moves the reed forward to beat up the weft, the forks of an elbow-forked lever enter between these wires, and, being pressed against the weft, are forced back a little, thereby raising the hooked end of the lever, which is the heavier. But when the weft-thread fails, the forks project through the wires, and the hooked end of the lever falls by its own weight, and is caught by another hook, formed in the segmental head-piece of a vibrating lever and drawn back. By this movement a horizontal lever is made to strike the knocking-off rod, which shifts the belt from the fast to the loose pulley, and lifts the click of the taking-up apparatus out of the teeth of its ratchet-wheel."

Fig. 7142.



*Cotton-Weigher's Beams.*

**Weft-hook.** (*Weaving.*) One for drawing in the filling in the case of *slat-weaving looms* and some forms of narrow-ware and ribbon looms.

**Weel.** A trap-basket to catch fish. *Weal.*

**Weigh-beam.** Fig. 7142 shows one of Fairbanks's weigh-beams, adapted for cotton-bales or barrels, but by suspending a suitable cradle, pig-iron, hams, or any other merchandise may be weighed.

**Weigh-board.** (*Mining.*) Clay intersecting the vein.

**Weigh-bridge.** A scale for weighing loaded vehicles.

**Weigh'ing-scale.** A contrivance for ascertaining the weight of an object. Considered under BALANCE; DYNAMOMETER; SCALE; etc.

The compound lever weighing-scale was invented by Thaddeus and Erastus Fairbanks of St. Johnsbury, Vt., who obtained their first patent for the same, June 13, 1831.

The first scale described in the patent as a "machine for weighing heavy bodies" was a comparatively small affair, and was designed for a special emergency. The farmers of Vermont, whither the brothers Fairbanks had removed from Massachusetts, in 1815, and commenced the manufacture of stoves and plows, had engaged largely in the culture of hemp, and found the ordinary steelyard a somewhat inconvenient means of weighing. From this special machine the whole business has grown. They now manufacture 400 different sizes and modifications, a few of which are shown on Plate LXXIII. The usual run of the modification in a given line may be judged from the following partial list: —

| Kinds. | Varieties. |
|---|---|
| Railway-track scales | 30 |
| Hog, depot, and stock | 35 |
| General-use platform-scales | 80 |
| Grocer's and counter use | 100 |
| Druggist's and prescription | 24 |
| Gold and coin | 18 |
| Weighmaster's beams | 47 |
| Post-office | 7 |

The factory now employs 500 men inside, and several hundred outside; making 50,000 scales annually.

Accuracy must always be the greatest merit of a scale. If it break down under its bearings it is no scale at all; if it fail to act promptly with the addition or subtraction of a relatively small weight when nearly empty, or when loaded nearly to its capacity, it fails in quality; just as a watch fails in the test for *isochronism* when it runs relatively faster or slower when just wound up or nearly run down. The difference of a very small fraction of a grain is quite sufficient to affect the assayer's scale; the addition of a bucket of water will throw out of poise the beam of the 300-ton canal-Fairbanks-boat scale.

The test for *position* in watches has its parallel also in the test of platform-scales, in which large masses of metal are placed alternately on the different corners of the platform.

They are sold all over the world and adapted to the standards of all nations, being marked with the peculiar sign of each. Hon. Thaddeus Fairbanks received the Order of Francis Joseph in 1873.

The essential points in the Fairbanks scales are: 1. The conveyance of a precisely known, often very small fraction of the weight of the commodity to the graduated beam, this being at a point of easy inspection. 2. The broad open platform, at the level most convenient for the reception of commodities.

The weight of the platform is distributed upon the shorter arms of a series of steelyard levers, whose longer ends are connected by an upright rod with a horizontal graduated beam with sliding and attachable weights.

Some of the features once peculiar to this scale are now open to the world, the patents having expired; but it is understood that there are yet twenty-two living patents which protect special features.

Emery's scale of January 30, 1872, and subsequent patents, is an application of the hydrostatic principle, the platform resting upon pistons in cylinders containing water; a portion of the pressure is transferred by pipes to the graduated beam, the whole being the converse of the hydrostatic press, in which the pressure of a column of water of small area through a pipe is made to act beneath a piston in a cylinder of much greater relative area.

Emery's testing-machine, made for the "United States Commission for testing iron and steel," is constructed on the same principle.

**Weigh-shaft.** The rocking shaft used in working the slide-valves by the eccentric.

**Weight.** A piece (usually) of metal of known gravity and used with scales to determine the gravity of other bodies.

The weights of ancient Egypt were often rings of metal or little images. The public weighers are represented at their avocations in the pictures at Thebes. See BALANCE, Fig. 530, page 213.

The Roman weights were of lead, stone, or bronze. Some were cubes, rings, disks, and some were shaped like the lower half of a pear. A pair of scales, a touchstone, a nest of weights inscribed with the names of Trajan, Constantius, and Chlorus, and a decayed wooden case, were found in a Roman barrow in England.

PLATE LXXIII. SOME OF THE FORMS OF THE FAIRBANKS SCALES. *See page* 2753.

In England (1876) there are ten different systems of weights, most of which are established by law: —

1. The *grain*, computed decimally, for scientific purposes.
2. Troy weight.
3. Troy ounce, with decimal multiples and divisions, called *bullion weight*.
4. Banker's weights for sovereigns.
5. Apothecaries' weight.
6. Diamond weight and pearl weight, including the *carat*.
7. Avoirdupois weight.
8. Weights for hay and straw.
9. Wool-weights; using as factors 2, 3, 7, 13, and their multiples.
10. Coal-weights, decimal numbers 1, .5, .2, .1, .05, .025.

Besides these the gramme, etc., of French metric system, are used by many scientists.

There are also ten different *stones*.

A *stone* of *wool* at Darlington is 18 pounds.

A *stone* of *flax* at Downpatrick is 24 pounds.

A stone of flax at Belfast is 16¾ pounds, and also 24½ pounds.

The hundred weight may mean 100, 112, or 120 pounds.

A pound weight varies in the avoirdupois and the troy.

Weights for small scales are *nest*, *cup*, *ring*, or *disk*.

**Weight'ed Lathe.** One in which the rest is held down firmly on the shears by a suspended weight.

**Weight'ing.** (*Founding.*) When the flasks in which a mold has been made cannot be held together by *cotters*, *glands*, or *clamps* alone, the top part has to be held down by weights placed upon it, so as to enable it to resist the upward pressure of the metal. Every four inches perpendicular hight of liquid cast-iron exercises pressure of one pound on the square inch; and when high *gates* are used, considerable force is necessary to hold the boxes together.

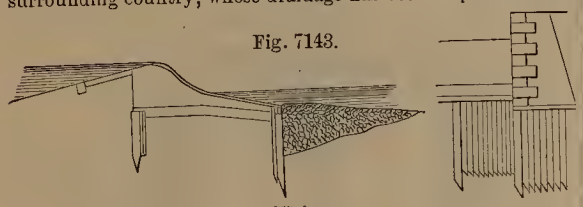
**Weight-nail.** (*Nautical.*) A nail heavier than a *deck*-nail, and used for fastening buttons, cleats, etc.

**Weight-rest.** (*Lathe.*) One which is held steadily upon the shears by a weight suspended beneath.

**Weir.** 1. A dam across a stream to raise the level of the water above it. The water may be conducted to a mill, a sluice, or a fish-trap.

In the fourteenth and fifteenth centuries and earlier, and indeed down to the present date, the mill-privileges on the streams of England have been improved at the expense of the surrounding country, whose drainage has been impeded thereby. In 1351, in the reign of Edward III., a special commission was issued to demolish all dams which impeded navigation, the act of Parliament refusing to allow compensation for said demolition. Seventy-six years afterward, under Henry VI., a survey and commission was ordered for the same purpose. From that day to this the interests of the landholders and millers have been at variance, the latter being to some extent aided by the interests of the slack-water navigators on many streams. Within a few years it was shown that on many streams in England the original sill of the factory over which the water flowed to the wheel is now buried 8 to 10 feet deep in the soil, and the head increased that much, minus the silt or filling in below which had backed up the tail-water. The effect has been to make marshes; "villages," as one authority states, "having been thereby placed in a morass, their soil, once loose and dry, becoming saturated with water."

Fig. 7143.

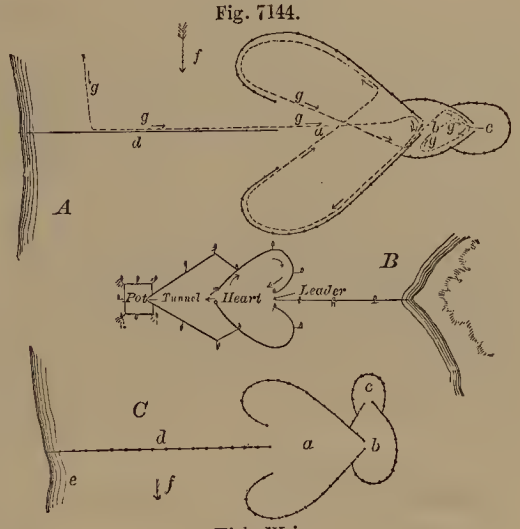


*Weir.*

Much engineering talent has been bestowed on weirs, and many noble examples are found on the American streams both East and West.

2. An inclosure of stakes or nets, forming a fish-trap or pond.

Fig. 7144.




*Fish-Weirs.*

*A* (Fig. 7144), salmon-weir, No. 1, Penobscot River.
*a*, great pound.
*b*, second pound.
*c*, fish-pound.
*d*, leader.
*e*, shore.
*f*, direction of current.
*g*, course of fish.

*B*, improved pound-net of Lake Erie.
*C*, salmon-weir, No. 3, Penobscot River.
*a*, great pound.
*b*, second pound.
*d*, leader.
*e*, shore-line.
*f*, direction of current.

**Weir-table.** A table by which the number of cubic feet of water per minute can be ascertained by means of weirs.

The table indicates the number of cubic feet per minute for each inch in width, and from one to eighteen inches in depth. The water must be set back to a dead level before it passes over the weir-board, and must have a clear discharge below the weir: —

| Depth of water in inches. | Cubic feet per minute, according to DuBut's formula. | Cubic feet per minute, according to experiments made in Scotland. | Depth of water in inches. | Cubic feet per minute, according to DuBut's formula. | Cubic feet per minute, according to experiments made in Scotland. |
|---|---|---|---|---|---|
| 1 | 0,403 | 0,428 | 10 | 12,748 | 13,535 |
| 2 | 1,140 | 1,211 | 11 | 14,707 | 15,632 |
| 3 | 2,095 | 2,126 | 12 | 16,758 | 17,805 |
| 4 | 3,225 | 3,427 | 13 | 18,895 | 20,076 |
| 5 | 4,507 | 4,789 | 14 | 21,117 | 22,437 |
| 6 | 5,925 | 6,395 | 15 | 23,419 | 24,883 |
| 7 | 7,466 | 7,933 | 16 | 25,800 | 27,413 |
| 8 | 9,122 | 9,692 | 17 | 28,258 | 30,024 |
| 9 | 11,844 | 12,564 | 18 | 30,786 | 32,700 |

**Weld.** The junction of metals by heating and hammering the parts. It differs from soldering and brazing in that no more fusible metal is made to form a bond of union between the parts. The partial fusion of the parts may be assisted by a flux; borax, for instance.

Great pressure may make a perfect weld without applied heat. It is probable that heat is developed at the point of junction.

**Weld'ed Tube.** A gas or water pipe made of a skelp bent to a circular form, raised to a welding-heat in an appropriate furnace, and as it leaves, almost at the point of fusion, it is dragged by the chain of a draw-bench through a pair of bell-mouthed jaws. These are opened at the moment of introducing the end of the skelp, which is welded without the agency of a mandrel.

They are made from six inches, internal diameter, and $\frac{1}{8}$ to $\frac{3}{8}$ inch thick, to $\frac{1}{4}$ inch diameter with $\frac{1}{10}$ inch bore. See TUBE.

**Weld'ing.** The process of uniting two pieces of a fusible material together by hammering or by compression while softened by heat. This process is

applicable to but few of the metals, iron, fortunately, being pre-eminent among these.

Platinum also possesses this property, which is availed of in forming the granules, in which it is received from its sources of production, into masses of sufficient size to be practically useful in the arts. Horn, tortoise-shell, and a few other substances may also be joined by welding.

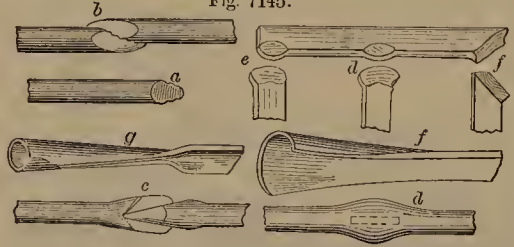
By far the most common and useful application of the process is, however, in uniting iron to iron or to steel.

This is, except in special cases, effected under the hammer, and at a particular degree of heat just above whiteness, known as the welding heat, when iron begins to emit vivid sparks.

The welding temperature of steel is, on account of its greater fusibility, considerably less than that of iron.

The process, technically called *shutting together* or *shutting up* is effected where the ends of two pieces of moderate size are to be joined, by bringing the ends of each piece to about a white or working heat, upsetting the ends to thicken them,

Fig. 7145.




*Welding.*

forming a widely stepped scarf (*a*, Fig. 7145), and again placing them in the forge until each is at the point of iguition; a little sand is then sprinkled over each, which fuses and spreads, serving to prevent oxidation of the surfaces.

The smith and his assistant each take a piece, and, striking them across the anvil to remove any loose cinders, place the ends together as at *b*, when the smith with the hand-hammer sticks them together, and, the helper joining in with his sledge, the two finish the operation and smooth down the work. This requires to be done with rapidity, "striking while the iron is hot." The smith afterward jumps the end of the rod upon the anvil, partly to test the soundness of the work; but principally to enlarge the part should it have become reduced below the general size.

In very heavy works the welding is principally accomplished within the fire, the two parts being previously prepared in the form of the *tongue* or *split-joint c*, or the but-joint *d*. When at the proper heat, they are jumped together endways, while suspended from the crane, afterward struck on the ends with sledge-hammers, and, the heat being maintained, the work is withdrawn from the fire and finished on the anvil. The but-joint is frequently strengthened, as in the case of large shafts, by *stick-in pieces*, *dowels*, or *charlins*, which are heated at another fire and inserted into notches cut in three or four sides of the joint, the whole being well hammered at the welding heat.

When two bars are required to form a T-joint, the transverse piece is thinned down as at *d*; for an angle or corner the form *e* may be adopted; but *f*, in which each part is cut off obliquely, is preferable. In most cases where two separate bars are to be joined, the metal should be first upset and then set down in ridges upon the edge of the anvil, or with a set-hammer, as the plain chamfered or sloping surfaces are liable to slide asunder when struck by the hammer. When a T-joint is made of square or thick iron, the one piece is upset and molded with the fuller, much in the form of the letter; it is then welded against the flat side of the bar; such works are sometimes welded with dowel or tenon joints.

The conical sockets of chisels, and a variety of other implements, are formed from bars of flat iron, which is spread out sideways by the hammer, and then bent (*f*) within a semi-circular bottom tool, after which the sockets are still more curled up by blows on the edges and finished (*g*) upon a tapering mandrel, so that the two edges somewhat overlap at the mouth of the socket, and meet pretty uniformly for the remainder of the length; an inch or more at the mouth only is usually welded, but sometimes the whole length.

For the method of making and welding gun-barrels and wrought-iron tubing, see GUN-BARREL; TUBING; WROUGHT-IRON.

Borax, either alone or mixed with other substances, is frequently employed in place of sand, particularly when steel is to be welded. A variety of these compositions have been recommended: —

1. Borax, 10; sal-ammoniac, 1. Pound or grind together, and melt them into a clear liquid. Pour the liquid out, and, when cool, pulverize for use.

2. Borax, 5 pounds; sal-ammoniac, 1 pound; prussiate of potash, ½ pound; rosin, ½ pound; alcohol, ½ pint; water, ½ pint; iron-filing, ½ pound. Melt them in an iron pot, over a gentle fire; allow the compound to boil for a few minutes, until it becomes dry and charred; then pulverize.

3. A Belgian patented composition consists of iron-filings, 1,000; borax, 500; balsam copavia, or other resinous oil, 50; sal-ammoniac, 75. They are mixed, heated, and pulverized.

4. Borax, 15; sal-ammoniac, 2; prussiate of potash, 2. Dissolved in water, which is gradually evaporated at a low temperature.

5. Schierloh's patent. Calcined borax, mixed with wrought-iron, reduced by grinding or other means to particles a little larger than coarse filings. Applicable for steel-facing rails and other large welds.

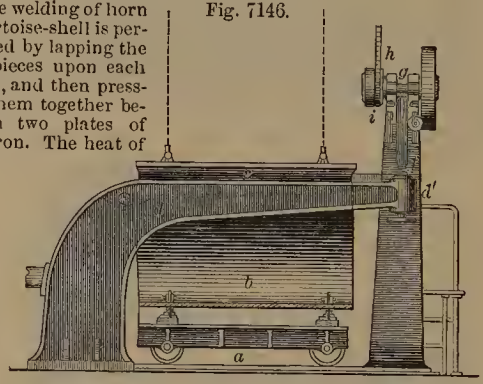
6. "Antimonoid." A German welding-powder, composed of iron-turnings, 4; borax, 3; borate of iron, 2; water, 1.

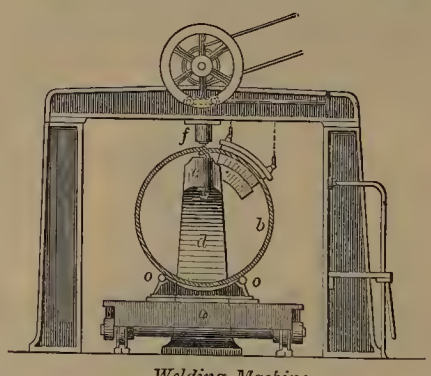
Mr. Rust, Bavarian inspector of salt-works, writes to Dingler's "Polytechnic Journal," that he succeeds perfectly in welding copper by using the phosphate of soda and ammoniae, or, what is cheaper, a mixture of 1 part phosphate of soda and 2 parts boracic acid. The welding-powder should be strewn on the surface of the copper, at a red heat; the pieces are then heated up to a full cherry red, or yellow heat, and brought immediately under the hammer. Great care must be taken that no charcoal or other solid carbon come in contact with the points to be welded, causing the production of a phosphide of copper, which would effectually prevent a weld. On account of the softness of the copper at its welding point, less force must be exerted in uniting the two by means of the hammer.

W. B. Adams (English) welds by making a close joint to the parts and heating by jets of gas and air supplied under pressure.

The welding of horn or tortoise-shell is performed by lapping the two pieces upon each other, and then pressing them together between two plates of hot iron. The heat of the iron is prevented from injuring the shell by the interposition of a wet linen cloth, and by immersing the whole in hot water.

Fig. 7146.




*Welding-Machine.*

**Weld'ing-ma-chine'.** One for uniting the edges of plates previously bent, so as to lap within a chamber when they are exposed to a gas-flame, and from which they pass to the rolls or hammer which completes the joint.

In Fig. 7146, *A* is a sectional and *B* an end view of a machine for welding plates, patented by W. S. Sutherland of Liverpool, England. It consists of carriage *a*, on which the tube *b* to be welded is placed, supported on rollers *o o*. The furnace *c* is of peculiar construction, carried by the arm *d*, which, in the example, also carries the adjustable anvil *e*; *d'* is an air supply-pipe. Above the anvil is the hammer *f*, worked by an eccentric on the shaft *g*, the eccentric being driven by a band *h* on a pulley *i*. In some cases the furnace is carried by chains, so as to be raised and lowered easily. There is an arrangement for

adjusting the hammer to suit various thicknesses of plates. The edges to be welded are heated in the furnace, and the tube is then run under the hammer and partially revolved, to bring the joint directly between the hammer and anvil.

**Weld'ing-swage.** A block or fulling-tool for assisting the closure of a welded joint. See SWAGE.

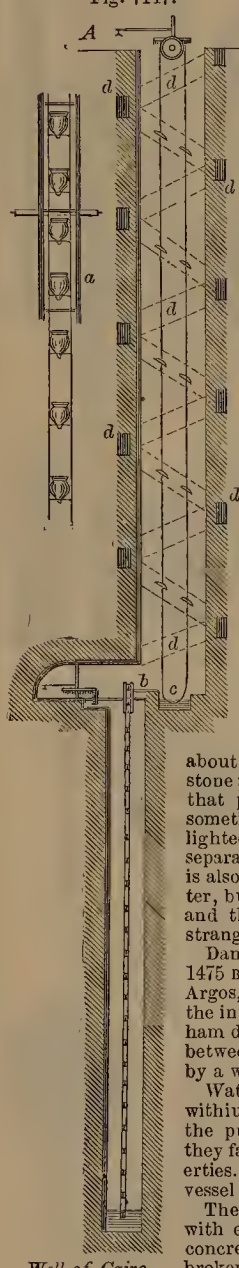
**Well.** 1. A shaft dug or bored in the ground to obtain water. Lately, some of the deepest have been in search of brine and oil. See ARTESIAN WELL.

The wells of Beersheba, dug by Abraham and re-dug by Isaac, are yet in existence. There are two large ones and five smaller ones. The larger of the two is 12½ feet across, and 44½ feet to the water. The curbstoues of the wells, around the mouth, are worn into deep furrows by the ropes of centuries. The remains of a town are in the neighborhood, but no habitations, shrubs, or trees. The generations of Abimelech, the sons of Samuel who "turned aside after filthy lucre" and "took bribes," the idolaters of the time of Amos, the returned Jews under Nehemiah, the Christians of the time of Jerome, have passed away, but have left these holes in the ground for an enduring record.

Jacob's well at Syehar — the ancient Shechem — has been visited by travelers in all ages and has been minutely described. It is 9 feet in diameter, and 105 feet deep, made entirely through rock. When visited by Maundrel it contained 15 feet of water.

The well of Joseph, at Cairo, is the most remarkable work of its kind on record.

Fig. 7147.




*Well of Cairo.*

*A* (Fig. 7147) is a section of this well. Its age and the name of its designer are unknown; by the common people it is generally ascribed to the patriarch Joseph; some formerly believed it to be the work of genii, while other authorities attribute its construction to the Saladin of the Crusades, whose real name was *Yussuf*, or Joseph; and still others to a vizier named Joseph, 800 years ago.

It is excavated in the solid rock, with a section of 18 × 24 feet to the depth of 165 feet, where an enlarged chamber *b* is formed, in which is cut a reservoir for the water brought up from below; from this point another shaft, not in the same vertical line with the upper one, is sunk to a farther depth of 130 feet, when a bed of gravel is reached, from which the water is obtained. The whole depth is 297 feet.

Water is raised from the lower well by means of a chain of pots *a* — the *na ura* of the Arabs (see NORIA) — operated by the power of horses or oxen turning wheels within the chamber *b*, and is emptied into the reservoir *c*, whence it is drawn up to the mouth of the well by a second chain of pots raised by animals at the surface. To enable the animals and their attendants to reach the chamber *b*, a winding passage *d d*, 6 feet 4 inches wide and 7 feet 2 inches high, is cut in the rock, surrounding the well and separated from it by a partition of about 6 inches in thickness left in the solid stone; this passage has so gentle a slope, that persons mounted on asses or mules sometimes ride down it; it is faintly lighted by windows cut through the thin separating wall. In the lower shaft, a path is also cut down to the bottom of the water, but as there is no partition between it and the well, its descent is dangerous to strangers.

Danaus, who came from Egypt about 1475 B. C., may have introduced wells into Argos, but he is scarcely to be credited with the invention, as recorded by Pliny. Abraham dug wells 1892 B. C., and the interview between his servant and Rebecca took place by a well of water about 1857 B. C.

Water was scarce in Attica. Neighbors within 4 furlongs were allowed to come to the public wells if after digging 60 feet they failed to find water on their own properties. They might fill at the public well a vessel of 6 gallons twice a day.

The Roman wells were *steined*, or walled, with concrete, to prevent filtration. The concrete was made of pure, rough sand, broken flint, and lime. The proportions in the mortar were: pure sand, 5; lime, 2 parts. The flints were combined in the mass, lining the sides and bottom of the excavation.

Contrary to some of the suggestions of writers on this subject, we do not suppose that *boring* for water was practiced in the patriarchal times in the countries bordering on the Mediterranean, but think it probable that they were dug and quarried, as the text of Genesis and the appearance of the ancient wells would indicate.

The Chinese mode of boring wells has been practiced in that country from time immemorial, and is thus described by the Abbé Imbert, a French missionary: —

"There exist in the province of Ou-Tong-Kiao many thousand wells, in a space of ten leagues long by five broad. Each well costs about one thousand and some hundred taëls (the taël is worth 6*s.* 3*d.*). These wells are from 1,500 to 1,800 feet deep, and of a diameter of from 5 to 6 inches.

"To bore them, they commence by placing in the earth a wooden tube of 3 to 4 inches diameter, surmounted by a stone curb pierced by an orifice of 5 to 6 inches. Then a trepan, weighing 300 or 400 pounds, is allowed to play. A man, mounted upon a scaffold, depresses a lever which raises the trepan 2 feet high, and lets it fall by its own weight; the trepan is attached to the lever by a cord of rattan, to which a strip of wood is fixed; a man seated near the cord seizes this strip at each elevation of the lever, and gives it a half-turn, so that the trepan, in falling, may take a different direction. The workmen are changed every six hours, and the work goes on night and day. They are sometimes three years in boring these wells to the depth necessary to reach the springs they are intended to attain."

See ARTESIAN WELL.

In Europe, the province of Artois has been noted for its bored wells since early in the twelfth century, and one is shown at Lillers which is believed to have been bored in 1126. See ARTESIAN WELL.

The arms of Modena, several hundreds of years back, were a pair of well-boring augers; and a professor of medicine of that city wrote, in 1691, a treatise on "physics," which explained the mode of boring for water.

The first notice of boring in England was not for the purposes of a well, but to ascertain the solidity of the foundation of St. Paul's, a number of crypts and structures having successively stood upon the same spot, and it was difficult to determine how much of the slight eminence was débris and how much reliable for supporting the ponderous building Sir Christopher Wren designed to erect.

Toward the end of the last century, the practice of boring was not uncommon in England, and a number of artesian wells were obtained, one especially in London, which was dug and bored 260 feet.

Gas from bored wells is now used extensively in and near Pittsburgh, in heating furnaces. See also GAS, page 244.

The Burns gas-well, on the Duffy farm, 35 miles from Pittsburgh, emits 1,000,000 cubic feet of gas per hour, weighing 58¾ tons. The gas is $C^4$ $8^6$, or 80 per cent of carbon and 20 of hydrogen. The pressure of gas is 200 pounds to the square inch. The delivery of gas is 1,408 tons per day, or 1,126 tons carbon, 282 tons hydrogen, equal to 1,250 tons anthracite coal, or the charcoal made from 5,000 cords of wood; estimated to be equal to the wood obtained by clearing 125 acres of forest, sufficient in smelting iron ores to make 700 tons of pig-iron daily. See "Galaxy," January, 1876.

One of the deepest, if not the very deepest, bore-hole which was ever sunk, is 24 miles south of Berlin, near the village of Spereuberg, where a small hill, composed of gypsum, crops out in the diluvial plane of Brandenburg. The presence of gypsum so near the capital caused the Prussian mining authorities to search there for rock-salt, and, in 1867, a bore-hole of 15½-inch diameter was begun at that place, in the gypsum rock itself. This rock was sunk through for 273½ feet, when antrydrite or antrydric sulphate of lime was met with, which, however, after a depth of only 5 feet, gave place to rock-salt, which was struck quite pure at a depth of 284 feet from the surface. The bore-hole was continued, and at the end of 1868 it had reached 956 feet, and had still an inner diameter of 12½ inches, after three sets of iron tubes had been inserted. Since the beginning of 1869 boring commenced with steam-power, and by the end of that year the bore-hole was sunk to 2,527 feet, by the end of 1870 to 3,479 feet, and in 1871 it was stopped at a depth of not less than 4,052 feet Rhenish, or 4,170 feet English, from the surface, which is the greatest depth that has ever yet been reached. The strata of rock-salt is 3,768 Rheuish feet.

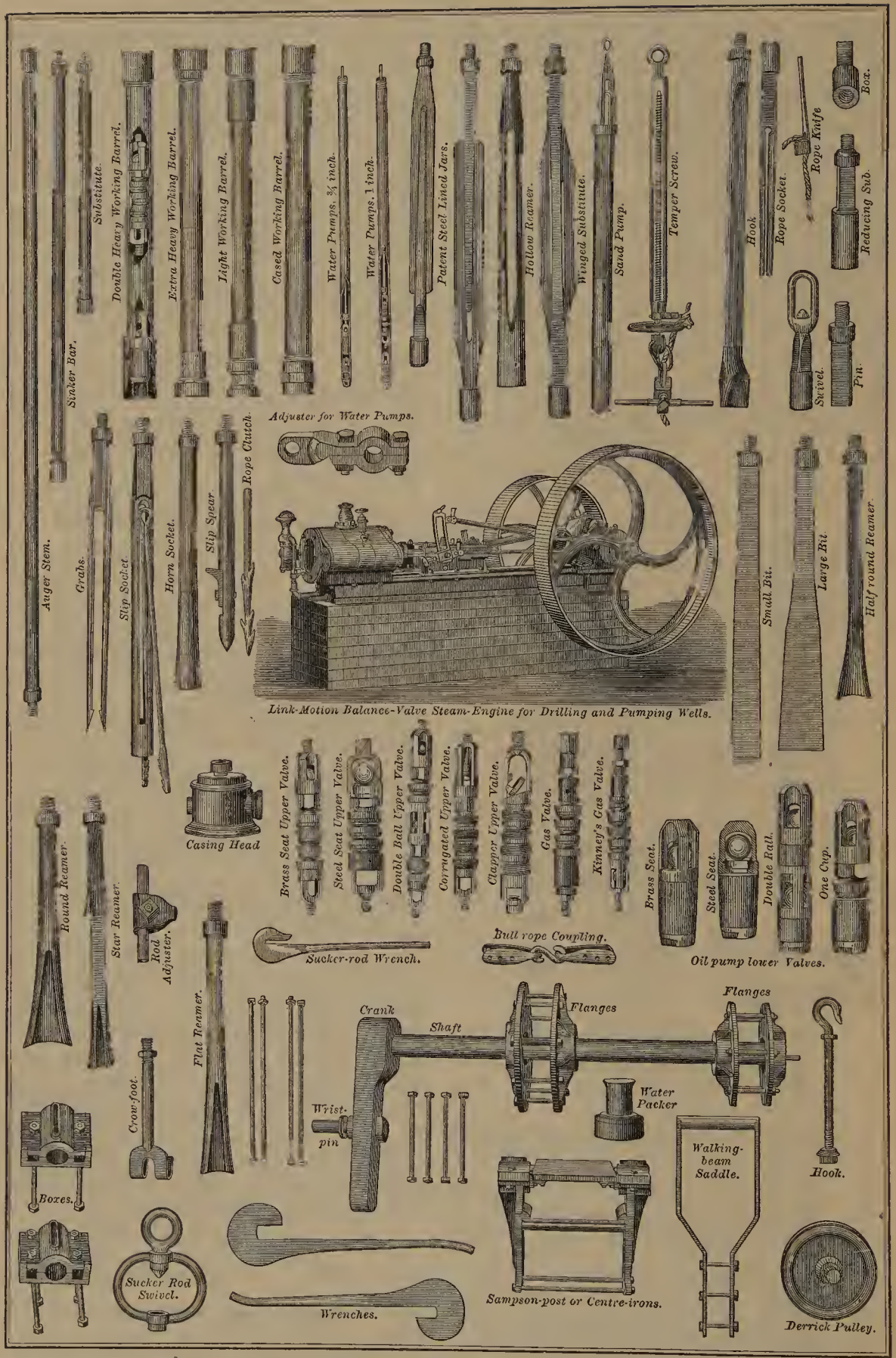
2. (*Mining.*) The lower part of a furnace, into which the water falls.

3. (*Nautical.*) *a.* A boarded inclosure for the pump-stocks.

*b.* A portion of a vessel's hold open to the sea, for keeping live fish.

4. A deep cavity in a building, occupied by the stairs.

**Well-bor'ing Jar.** The *jar*, or slide-joint, is the invention of Oeuyenhausen. See Plate LXXIV.




TOOLS AND IMPLEMENTS FOR DRILLING AND PUMPING OIL OR ARTESIAN WELLS.

PLATE LXXIV. (*Gibbs and Sterrett, Corry and Titusville, Pa.*)

*See page 2759.*

It consists of two parts able to slide upon each other for a distance of about 1 foot, and so arranged that during the descent one becomes detached from the other. The upper part is balanced by the counterpoise. When the horing-tool is allowed to descend after it has been raised for the purpose of getting the blow, it will strike the bottom simply with a weight equal to that of the lower portion, and the upper portion will descend gently through the distance of 1 foot until it rests upon the collar. Should it be required to bore without percussiou, the slide-joint is suppressed, and a common rod substituted; in that case also the lighter and weaker rods are replaced by stout bars able to resist an effort of torsion.

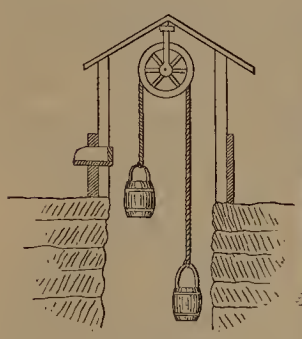
**Well-bor'ing Tools.** *Well-rig* is the term applied to the whole *plant* for well-boring, consisting of the *derrick*, its engine and operative parts, and the various tools, such as drills, reamers, sucker-rods, grabs, and adjusters; its casing-pipes, pump-rods, valves, casing-heads, swivels, couplings, and wrenches.

Plate LXXIV., opposite, shows a Gibbs and Sterrett (Titusville and Corry, Pennsylvania) full rig, the names of the parts being attached to them for facility of reference.

**Well-buck'et El'e-va'tor.** A common mode of elevating water is by reciprocating buckets, which are fastened to the ends of a chain plying over a wheel above in alternate directions. The empty one in descending forms a partial counterbalance for the ascending bucket of water.

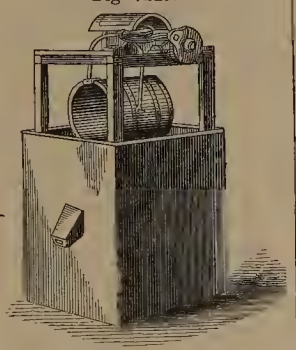
Fig. 7149 shows an arrangement by which the lip of the elevated bucket is engaged so as to tip the bucket and spill the

Fig. 7148.



*Reciprocating Buckets.*

Fig. 7149.

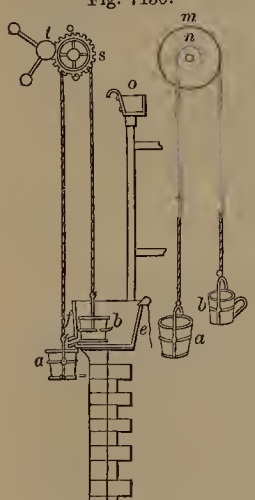


*Bucket-Tipping Arrangement.*

contents into a trough, which has a discharge-spout on the outside of the curb.

An automatic reciprocation of two buckets having varying capacities when full and weights when empty was invented by Gironimo Ferugio at Rome, in 1616.

Fig. 7150.

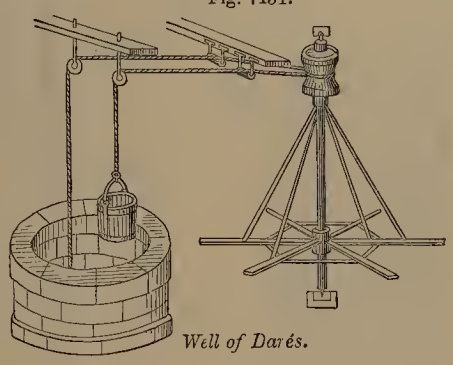



*Ferugio's Water-Elevator.*

The bucket *a* is larger than the bucket *b*, and consequently holds more, giving *a* the preponderance over *b* when full. When empty, *b* weighs more than *a*, being purposely weighted, giving *b* the preponderance when it descends for another load from the cistern. The tank *e* is constantly supplied with water, which as constantly escapes by the spout *f*. The water escaping from the cistern *e* into bucket *a* depresses the same and raises a smaller quantity of water in the bucket *b* to the elevated cistern *o*. On the middle hoop of the bucket *b* is an ear which catches the hook on the edge of the cistern *o*, so as to tilt the contents of the bucket into the cistern. The lower hoop of the bucket *a* has also an ear, which, at the bottom of the descent, catches upon a hook and tilts its contents. The buckets being emptied, the preponderance of weight is in favor of *b*, which descends, raising the bucket *a* to be again filled, and plunging itself in the cistern *e* to receive another supply.

The toothed wheel *s* engages a pinion *t* to insure regularity of motion, by means of a fly-wheel on the pinion-shaft. When the full of the bucket *a* is less than the elevation of the bucket *b*, a wheel and axle *m n* are employed, with a corresponding decreasc in the capacity of *b* in the proportion of the radii of *m n*.

Fig. 7151.



*Well of Darés.*

At Darés, near Dieppe, the garrison was supplied with water from a deep well by means of buckets raised alternately by a rope passing around a drum on a vertical axis rotated by 6 men, who each exerted a force of 25 pounds upon the ends of the levers, and raised 13 cubic feet of water at a haul.

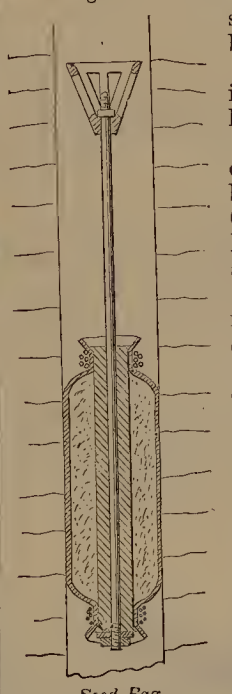
The Anglo-Saxons used the chain and wheel; the pivoted and weighted well-pole; two buckets on a chain with a wheel; buckets with iron hoops. See also SHADOOF; SWEEP; etc.

**Well-drill.** A tool for boring wells. See WELL-BORING TOOLS; ARTESIAN WELLS; etc.

**Well-hole.** A hollow newel in a staircase.

**Well-pack'ing.** A bag of flaxseed — known as a *seed-bag* — or some other material placed around a well-tube in an oil-well to isolate the oil-bearing strata from water above or below.

Fig. 7152.



*Seed-Bag.*

**Well-stair'case.** A winding staircase built around a hollow newel.

**Well-tube.** The driven-well, invented by Colonel Nelson W. Green, 76th Regiment New York Volunteers, at Cortland, N. Y., 1862. Used by the British army in Abyssinia. See TUBE-WELL.

Colonel E. L. Drake of New York, subsequently of Titusville, Pa., drove his oil-tubes to the rock, after which he bored. The practice of sinking fresh-water wells by this method has now become common in sections adapted to this mode.

Fig. 7153.

*Driven-Well Tube.*

Fig. 7153 shows one in which the inner tube — which prevented the passage of gravel or sand through the holes in the outer one while driving — is subsequently drawn up to expose the holes.

**Well-tube Fil'ter.** A strainer on a driven-well tube to keep back gravel. The illustration (Fig. 7154) has a strainer made by a coil of wire.

In Fig. 7155, the tube is shod with a conical plug, and the lower portion is perforated and lined with wire gauze.

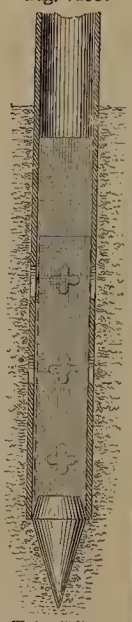
**Well-tube Point.** An auger or spear point at the bottom end of a perforated tube for a driven well (Fig. 7156).

**Welt.** A strip forming an additional thickness laid over a seam or joint, or placed in an angle to

Fig. 7154.

*Filter for Well-Tubes.*

Fig. 7155.



*Tube Filter and Point.*

strengthen it. Applied to a form of back-strip which covers a flush joint. See CARVEL-BUILD.

A joint or fold.

A border or edging.

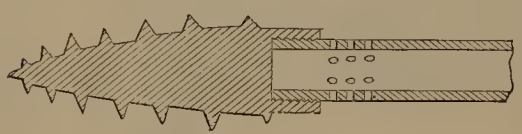
2. (*Shoemaking.*) A strip of leather around the shoe, between the *upper* and the *sole*.

3. (*Sheet-iron Work.*) A strip riveted to two contiguous portions which form a but-joint. As contradistinguished from a *lap* or *turned* joint.

4. (*Knitting-machine.*) A flap of work (as a heel-piece) disengaged laterally and knitted separately from the main body, and subsequently joined thereto by re-engagement of loops or by hand-knitting.

**Welt-cut'ter.** (*Shoemaking.*) A machine to cut the notches in the edge of the welt to permit it to be bent around and laid smoothly at the toe. The motion is by a treadle; this depresses the angular cutter, which is again raised by a spring.

Fig. 7156.



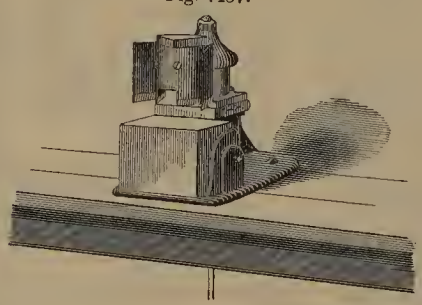
*Well-Tube Point.*

**Welt-guide.** (*Sewing-machine.*) An attachment for presenting the welt in the machine so as to be sewn by the needle to the other portion or portions of the boot or shoe. See SEWING-MACHINE ATTACHMENTS, G. W. Gregory, Boston, Mass.

**Welt-knife.** (*Shoemaking.*) A knife used to trim the welts of shoes and boots.

**Welt-ma-chine'.** (*Shoemaking.*) A machine to cut leather, cloth, etc., into a series of parallel strips, to be used as welts in side-seaming. The

Fig. 7157.

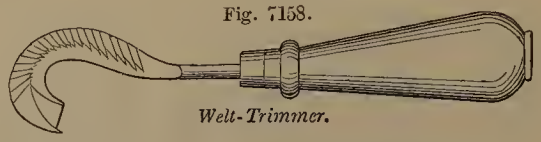


*Welt-Cutter.*

material is passed into the machine irrespective of its width, the end-knife separating the portion not cut into strips before it can be carried against the standard.

**Welt-trim'mer.** A cutting-tool for trimming the welts of shoes. The figure shows one composed of a beveled blade having a cutting edge, a guard, and a rasp on it, and provided with a shank and handle.

Fig. 7158.



*Welt-Trimmer.*

**Wet-dock.** In contradistinction to dry-dock, in which a vessel is placed for repairs, the water being pumped out.

A tidal or shipping-dock.

In the basin the water is maintained at such a hight as to float the vessels therein at all times. The dock is connected by a lock with the navigable waters, and the gates maintain the level of water in the basin irrespective of the hight or fluctuations of the water outside. The operation of locking a vessel in or out, except at flood-tide, when the outside and inside levels may be the same, is similar to the process of locking canal-boats. See LOCK-CANAL, page 1341.

The docks of Liverpool are the most extensive in the world. The wet-docks are 37 in number, having an area of 167.517 acres. The dry basins are 7 in number, with an area of 20.185 acres. The whole dock-water space is 235 acres, on the Liverpool side of the river. The graving docks are numerous, and the lineal yards of quay space amount to 19,195 yards.

Most of the docks have their own entrances to the Mersey, and the whole chain of docks are connected independently of the river. They also have inland canal and railway connections.

The dock-water space of Birkenhead, on the opposite side of the Mersey, is 153 acres.

The docks of London cover an area of 227 acres; 154 acres being on the Middlesex side, and the remainder on the Surrey side.

The tonnage of London is three times that of Liverpool, but the Thames has spacious and convenient moorings, while the shipping of the Mersey is necessarily accommodated in docks.

The mooriugs of the Thames afford berths for 461 vessels.

The number of vessels passing in and out of Liverpool in 1860 was 48,317; equal to 132 per day.

The docks of Liverpool are inclosed spaces taken from the river Mersey, the area afterward dug out.

The London docks are excavated in the land on both sides of the river.

The Bristol docks are made by walls and locks, which arrest the water of the river Avon, a new cut being made for the river, and for the passage of vessels up and down.

See list under DOCK.

**Wet-press.** (*Paper-making.*) The second press in which hand-made paper is compacted and partially drained of its water.

The sheets from the mold are laid in alternation with felt in the first press and subjected to pressure, 144 sheets of paper and the same of felt forming a *post*, which is the amount pressed at one time.

When a second *post* is ready, the first is removed from the press, taken apart, and the sheets made into a compact pile without the felts. Several of these piles are formed into one larger one which is placed in the *wet-press* for a final pressure.

The sheets from the wet-press are dried in bunches across strings, in the loft or drying-room.

**Wet'ting-ma-chine'.** A machine for damping paper for printers' use.

**Whale-boat.** A clinker-built boat, sharp at both ends, generally from 20 to 28 feet in length, and rather deep for its width; it pulls four or six oars and is steered by an oar; the ends have a considerable sheer.

Patent No. 73,484, of 1868, is for a whale-boat chock.

**Whale'bone.** Preferably called *baleen*, as the term *bone* is neither pertinent nor appropriate.

A horny substance occurring in long, thin plates, fringed at the edges and acting as a strainer to detain the whale's food when he ejects the water which he has swallowed with the medusæ and small fry which constitute his food. The principal source of whalebone is the *right whale*, so called, the *Balæna mysticetus* or *australis*. Some 300 of these plates are found in the mouth of an adult whale, and vary from 10 to 15 feet in length. The *baleen* is prepared by boiling and dyeing black.

Machines are made for cutting and splitting baleen. The following patents may be consulted:—

| | | | |
|---|---|---|---|
| No. 70,545 | 1867. | No. 121,520 | 1871. |
| 91,047 | 1869. | 145,539 | 1873. |
| 96,220 | 1869. | 145,770 | 1873. |
| 105,498 | 1871. | | |

Patent 20,299 is for an artificial whalebone.

Time has passed since the people of England reveled in whale meat. The whale was, however, eaten by the Saxons, and, when men were lucky enough to get it, it appeared at table late in the fifteenth century. In 1246, Henry III. directed the sheriff of London to purchase 100 pieces of whale for his table. Whales found on the coast were perquisites of royalty; they were cut up and sent to the king's kitchen in carts. Edward II. gave a reward of 20 shillings to three mariners who caught a whale near London Bridge. Those found on the banks of the Thames were claimed by the lord mayor, and added to the civic feast. Pieces of whale were often purchased in the thirteenth century for the table of the Countess of Leicester. England was supplied with this choice dainty by the fishermen of Normandy, who made it an article of commerce. The Normans had various ways of cooking it; sometimes it was roasted and brought to the table on a spit, but the usual way was to boil it and serve it with peas. Epicures looked out for a slice from the tongue or the tail. The grampus or sea-wolf was also highly esteemed, but, of all the blubber dainties, the porpoise was deemed the most savory. The Saxons called it sea-swine, and the ecclesiastics of the Middle Ages *porco-marino*. Porpoises were purchased for the table of Henry III. in 1246.

**Whal'ing-im'ple-ments.** See HARPOON; BOMB-LANCE.

Patents No. 3,290, of 1843, and 9,478, of 1852, are for machines for cutting blubber.

No. 8,843, of 1852, is an electric whaling-apparatus.

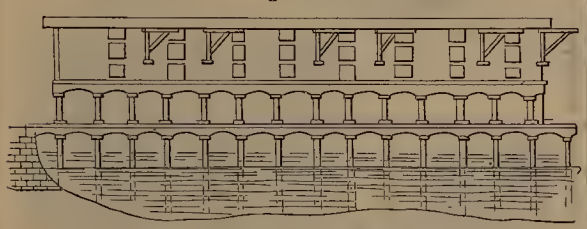
No. 35,476, of 1862, is for raising sunken whales. They have a disagreeable habit of sinking when the life is out of them, especially if the harpoons or lances have penetrated the carcass so that it collapses.

**Whang.** Tough leather adapted for strings, thongs, belt-lacing, etc. It is of calf-hide commonly, but better still is the tanned hide of a dog, ground hog, or raccoon.

**Wharf.** A landing-place for cargoes. A *quay* or *mole*.

Fig. 7159 is an elevation of a pier, wharf, and warehouse; the pier having an open way beneath it for the flow of the water, being constructed on iron columns, and the wharf having a

Fig. 7159.

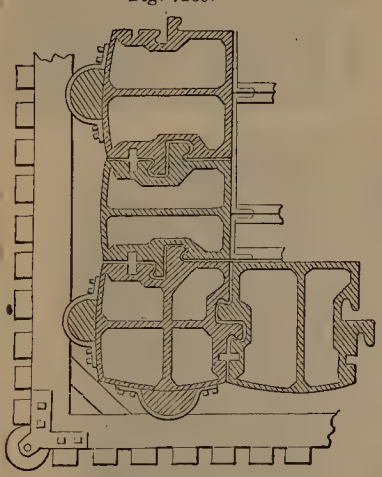


*Hyde's Pier, Wharf, and Warehouses.*

cart-way around it to facilitate loading and unloading vessels, and the delivery of freight from the warehouse.

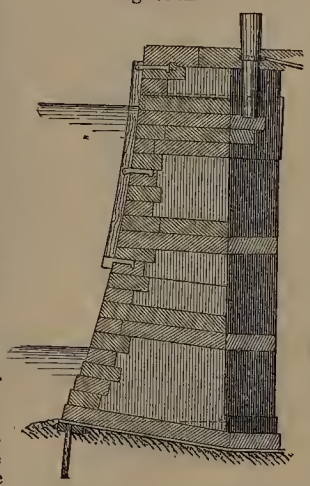
Fig. 7160 shows the application of iron to pier and bulkhead work. The hollow piers of metallic tubular sections are so formed that each tube or section is locked between two tubes or sections when arranged in lines or angles to form the pier of any desired shape, according to its location. The tubes, when two or more sections are set in place, are filled with cement, to exclude water. A chamber is formed partly in each tube, which, when two tubes are united, registers throughout the entire length of the tubes, and is filled with wood, plaster, or cement, to prevent the passage of water between them when in position. Lateral openings, protected by glass, in the separate sections, admit light to rooms in the interior of the pier.

Fig. 7160.



*Seely's Pier and Bulkhead.*

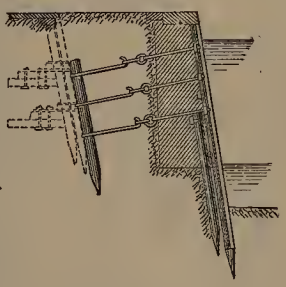
Fig. 7161.



*Sectional View of Retaining-Wall.*

Fig. 7161 is a sectional view of a retaining-wall employed for wharves in some English tidal harbors. The masonry is laid on a timber platform, the front of which is protected by sheet piling. The face of the wall is curved, to permit vessels to lay closer alongside, and is protected by perpendicular oaken fenders, secured by iron ties.

Fig. 7162.



*Section of Wharf at Blackwall, London.*

Fig. 7162 is a section of a wharf at Blackwall, London. The front is formed by a series of iron piles 7 feet apart, backed by shorter sheeting-piles, and anchored to other series of piles farther in shore. The spaces over the sheeting-piles are closed by iron plates bolted to the main piles and to each other, and backed by a wall of concrete.

Plate LXXV. is a view of the contemplated improvements on the river-front, New York City, showing the new system of piers and bulkheads.

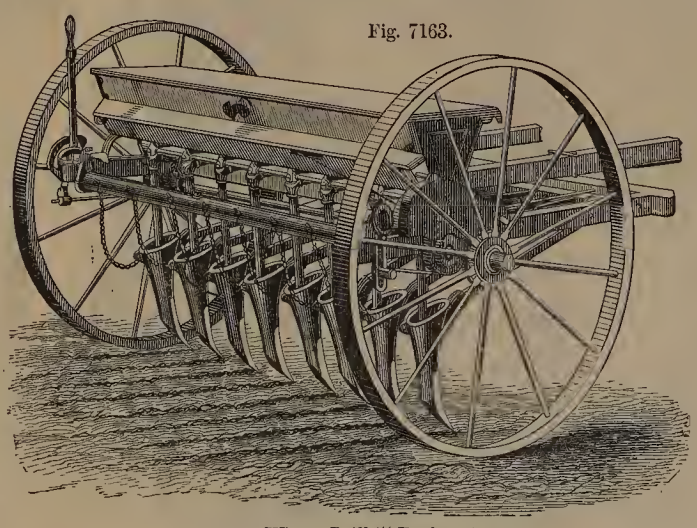
**Wharf'ing.** (*Hydraulic Engineering.*) A mode of facing sea-walls and embankments by means of driving upright planks in the manner of sheet-piles, the joints being backed by other planks, and the whole secured by land-ties and tightly driven earth in the rear.

**Wheat-drill.** A machine for sowing wheat and other grain in rows. Each hoe in the series opens a furrow, and the grain is led in by a rubber tube, which conducts the seed from the hopper.

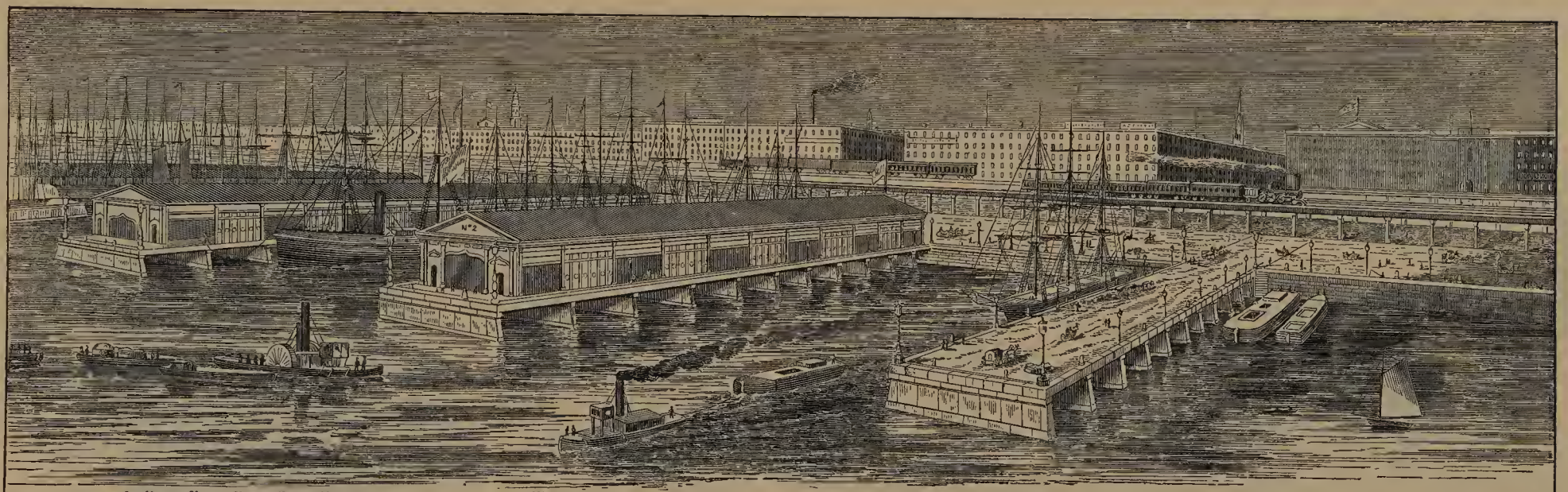
The improved drills of the present day have hoppers attached for sowing grass-seed or fertilizers, and some have arrangements for sowing grain or corn broadcast.

Fig. 7163 is a perspective view of Mast's wheat-drill (Springfield, O.). Fig. 7164 shows the *force-feed* wheel, one of which

Fig. 7163.



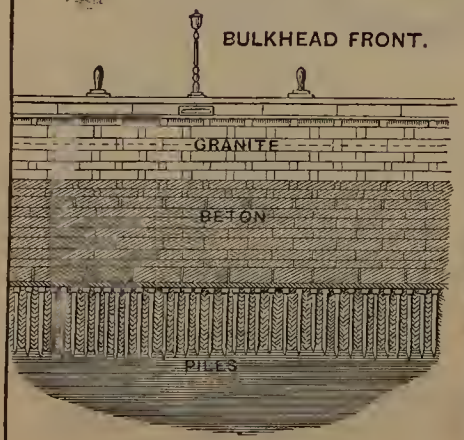
*Wheat-Drill* ("*Buckeye*").



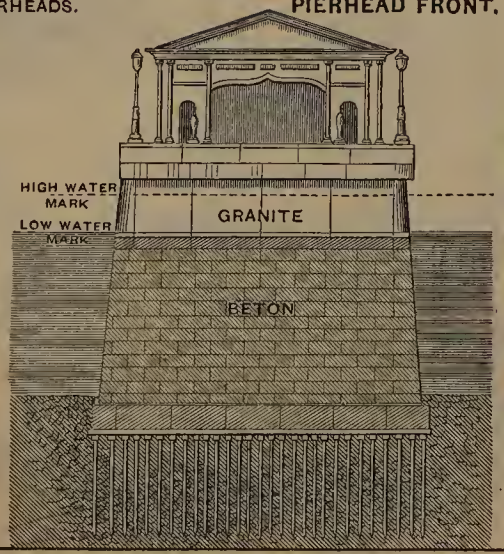
5 10 20 30 40 50 100 FEET

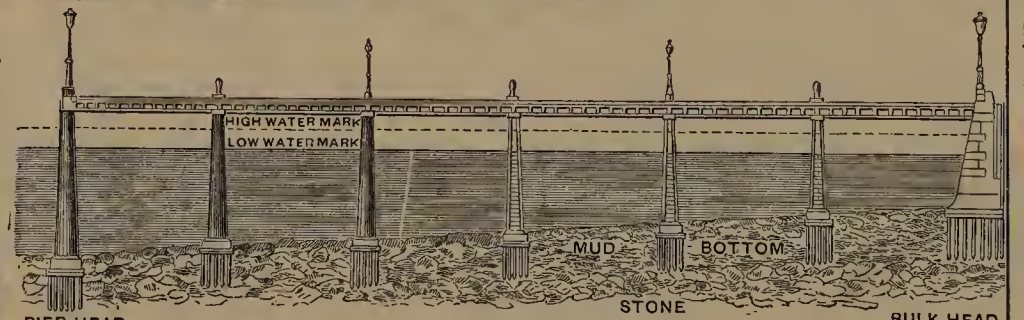
SCALE OF FEET FOR BULKHEAD & PIERHEADS.

BULKHEAD FRONT.




PIERHEAD FRONT.




*Longitudinal Section of a Pier with 6 supports.*

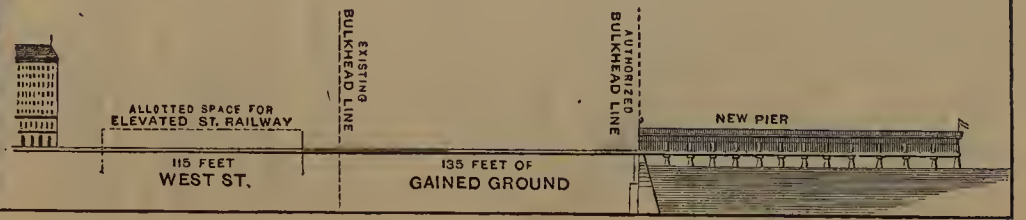
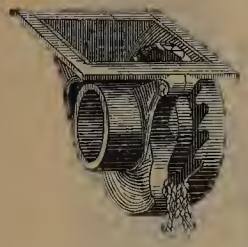



PLATE LXXV. PROPOSED WHARFAGE, PIERS, AND IMPROVED HARBOR-FRONT FOR THE CITY OF NEW YORK.

*See page 2761.*

is placed on the bottom of the hopper above each spout, to insure the feed and not depend upon the gravity of the grain. The feed is regulated from ½ bushel of wheat to 3 bushels of oats, without change of gears, by means of an adjustable rotary disk in the feed-cup, so arranged that all the feeders are set at once by merely moving the indicator at the end of the hopper.

Fig. 7164.

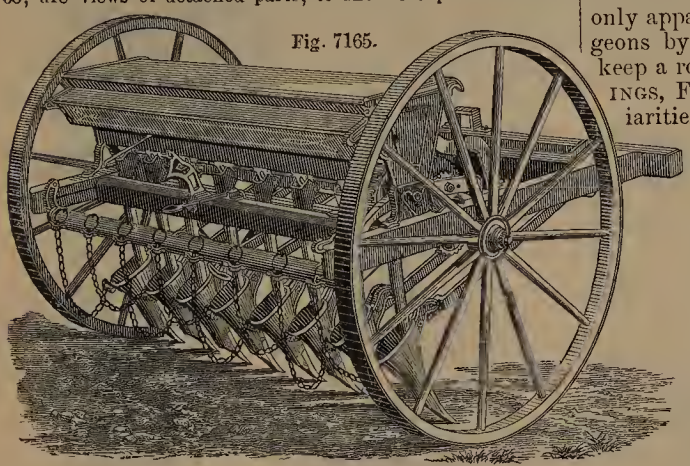


*"Buckeye" Drill Force-Feed.*

The hoes may be shifted from a double to a single bank, or *vice versa;* the feeders are thrown out of gear when the hoes are raised from the ground. A grass-seed hopper is placed on the rear, and a guano-sower may be attached to drill the fertilizer along with the grain. A spring hoe is used in rocky or rooty ground, to allow the hoe to spring back and avoid breaking.

Fig. 7165 is Kuhn's wheat-drill (Dayton, O.), and Figs. 7166–68, are views of detached parts, to show the peculiarities of

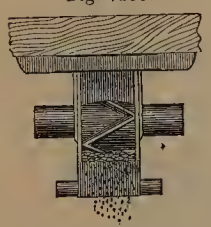
Fig. 7165.



*Wheat-Drill ("Farmer's Friend").*

the machine. The hoe-shifter is moved by a lever in the rear, to throw the hoes into single or double rank, one half of the drag-bars being attached to a movable frame, and the others to the frame of the machine. The zigzag feed-wheels

Fig. 7166.



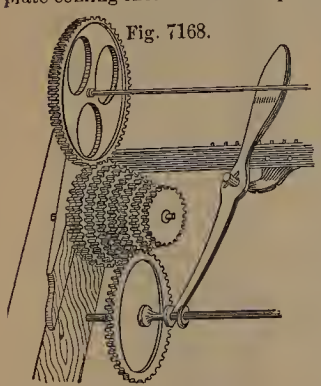
*Force-Feed Wheel Delivering Grain.*

Fig. 7167.

*Section of Force-Feed Wheel.*

working beneath the hopper, each above its own leader-spout, drive the grain from the feed-cup right and left, each oblique plate coming into action as its predecessor goes out of action, the rate of revolution determining the quantity sown. The drill ceases to sow when the hoes are lifted. Cog-wheels are used to change the quantity; these are bolted in a cone, and the changes controlled by a lever. The change is made by pressing on a lever to which the cone is attached, which raises it out of gear, and moving the wheel on the shaft right or left into any of the wheels of the cone. The rear end of the shifting lever moves over a notched plate where figures indicate what each wheel will sow.

Fig. 7168.



*Cone-Gearing.*

The machine has grass, fertilizer, and broadcast attachments. The latter consists of corrugated pans that are put under the feed-cup in place of the rubber tubes, and scatter the grain evenly in front of hoes which harrow it in.

**Wheat-hull'er.** A machine for decorticating wheat.

In the illustration (Fig. 7169), the rough-surfaced cone rotates reversely in the rotating conical screening-cylinder. The grain to be hulled or scoured is fed in between the core and cylinder. The cleanings are drawn by the forced current of air created by the suction-fan, while the clean grain is discharged by the endless screw.

It resembles in a degree the *hominy-machine*, being employed to take the skin from the grain.

**Wheel.** A circular frame turning on an axle.

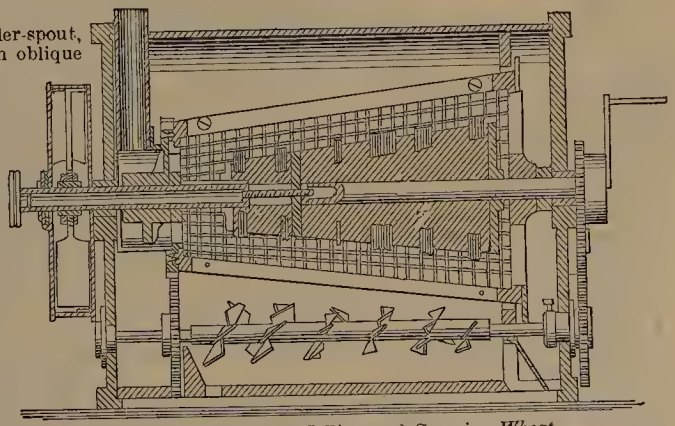
A wheel is distinguished from a roller by this feature, that the former has an axle upon which stress is imposed. The agricultural roller may seem to contradict this definition, but the discrepancy is only apparent. The axle is merely a pair of gudgeons by which the roller is hauled. An axle to keep a roller in place as it revolves is seen in BEARINGS, Fig. 619, page 259. The patentable peculiarities of wheels usually concern their special parts. See HUB, Fig. 2601, page 1139. See also SPOKE; FELLY; RIM; TIRE; BOX; SPINDLE; AXLE; etc. See list under VEHICLE, parts of.

The essential feature of a wheel is rotation, partial or entire. Its motion may be *intermittent*, *oscillatory*, or *continuous*. Its form may be *circular* or otherwise; its contour, *regular* or *irregular*. Its function may be to *transmit* motion or to *modify* it. Its application may necessitate *cogs* of a given form, or it may be *smooth*, its surface being free from contact with other portions of the machine. It may be hollow, for the *conveyance* or *measurement* of fluids; or it may be the means of *propulsion* of said fluids; or, conversely, it may be *propelled* by them. It may form a support, and, by rotation, be made effective in assisting transportation.

1. (*Vehicle.*) Wheeled carriages were comparatively rare in ancient times, excepting war-chariots. Of these many are cited; in the army of Jabin, under the command of Sisera, there were 900 chariots of iron. Solomon had 1,400 chariots. The wheels were not like the clumsy contrivances of barbarous modern nations, but more like our own. "The axle-trees of the wheels were joined to the base; and the hight of a wheel was a cubit and half a cubit" (perhaps 30 inches), "and the work of the wheels was like the work of a chariot-wheel; their axle-trees, and their naves, and their fellies, and their spokes were all molten" (bronze). (1 Kings vii. 32, 33.) The references to wheels in the Bible are frequent.

Homer mentions wheels with eight spokes. The ancient Egyptian wheels had usually, perhaps always, either four or six. Homer also mentions, as constituting a wheel, the wooden fellies, the spokes, the nave, and the metallic hoop or tire.

Fig. 7169.



*Machine for Hulling and Scouring Wheat.*

The Egyptian monuments also show all these, besides the linch-pin that holds the wheel on the axle, and the metallic bands that strengthened the connection of the spokes and fellies. The wheels were not over two to three feet high. See CART; CHARIOT.

In the Abbott collection of Egyptian antiquities, now in the possession of the Historical Society of New York City, are a wheel and tire and other portions of a chariot, found in a mummy-pit near Dashour. The wheel has six spokes, like those so frequently occurring in the paintings and sculptures. The hub of the wheel is a long wooden sleeve to run upon the axle, and was strengthened by bronze hub-bands, now missing, but shown clearly in colors in contemporary paiutings. The inner ends of the spokes are tenoned into the hub, and the outer ends into the fellies. The latter are six in number, and their ends are slanted off obliquely so as to make a lap-joint. On the outside of all is a wooden tire, now detached, and made of bent pieces, which meet with but-joints. There is little doubt that the junction of the fellies with the spokes, and of the parts of the tire, were strengthened by bronze clips.

In a European museum, at Berlin or Florence, is a Scythian war-chariot, which was brought, as a trophy probably, to Egypt in ancient times. (See CHARIOT, Fig. 1253, page 528.) In some of the large French folios on Egyptology it is represented on a scale which allows its construction to be observed. The wheel has a bronze sleeve around the hub, studded on its periphery with bronze sockets, which receive the inner ends of the spokes. The outer ends of the spokes are tenoned into the wooden rim, and strengthened at the intersections with bronze clips or straps, which formed bands around the rim, and were secured by bronze nails. See the folios of Lepsius, Champollion, Rosellini. See also Denon's "Description de l'Egypte" in the Congressional and Astor libraries.

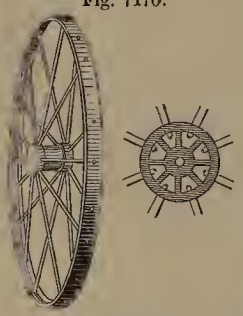
It may be mentioned that the chariot-horses of Egypt were *yoked* to the pole of the chariot, and pulled thereby. (See SADDLE, Fig. 4512, page 2009.) Traces were seldom used. Occasionally they had one trace on the side of the horse next to the tongue. It is not certain, even in this case, but that it was only a mode of coupling back the yoke to the pole, near the chariot. The yoke was secured by a vertical pin, which passed through the yoke and tongue.

The wheels of the ancient *plaustrum*, a farm cart or wagon, were of cross section of a tree-trunk, or of boards nailed together to form a circular disk. Such are still used in Greece.

The usual carriages of the ancients had two wheels, but four-wheeled carriages are shown in the Theban paiutings and elsewhere, and are carefully described by Herodotus. (See CART, page 485.) The *ferate orbes* of Virgil are wheels shod with iron. Persius, Martial, and others call the tire *canthus*. Pliny ascribes the invention of four-wheeled wagons to the Phrygians. (See Fig. 1253, page 528.) At Portici are the remains of a Roman chariot-wheel; a band of iron forged out of a single piece, about 48 inches in diameter, nearly 2″ broad and 1″ thick. A portion of the nave has been preserved, which is bound with iron, and this again by a bronze plate secured by brouze nails.

The common iron wheel of England has cast-iron hub (*nave*) and rim, and wrought-iron spokes. The rim has holes flaring to the outside, so as to hold the ends of the spokes, which have conical heads to fit the openings. The inner ends of the spokes pass through the outer rim of the hub, and are secured by nuts. The insertion of the spokes in circles near the ends of the hubs gives them an extended base or bearing, and strengthens the wheel against lateral strain.

Fig. 7170.



*Jones's Iron Wheel.*

The tires of wrought-iron wheels for locomotives and railway-carriages were formerly bent to form, being previously cut off with ridges in the center, so as in meeting to form two angular notches, into which two thin iron wedges are subsequently welded radially. The four parts thus unite together in the form of a cross, and make a firm joint without upsetting. They are now rolled or welded in single pieces and secured by bolts.

Some wrought-iron wheels have welded tire and spokes, the nave or hub being cast around the end of the spokes. In others, the spokes and tire are partially united by rivets. In Boume and Bradley's patent wheel (English) the hub, spokes, and tire are all of wrought-iron welded together.

Savart, in his experiments on the theory of sound (acousties), made wheels to revolve from 1,000 to 2,000 times per minute (see SIREN); but this has been surpassed by Foucault, who invented an apparatus for measuring the velocity of light, to which a small wheel with a mirror was attached, which might be made to revolve 600, 800, and even 1,000 times per second, or 60,000 times per minute. For such great velocities bands or strings are used.

2. (*Spinning.*) A hand-machine for twisting rovings or yarn. A SPINNING-WHEEL. It differs in form with the material and purpose. The use is described under SPINNING.

Figs. 7171, 7172, 7173, show respectively a flax wheel, card, and reel; a *wool-wheel;* and a *knot-reel* for skeining off *knots* of a given length from the cops on the spindles.

3. (*Nautical.*) An instrument by which the rudder is moved. A *tiller*-wheel. See STEERING-WHEEL.

4. (*Pyrotechnics.*) *Wheel-cases* are strong tubes made like rocket-cases, and filled with a composition which burns more slowly than rocket-filling.

They are placed on the edges of revolving wheels, in the direction of the plane of their framework, in order to impart a rotary motion, at the same time giving out long rays of sparkling light.

*Sun-cases* are similar to the above.

*Catherine-wheels* are revolving wheels, whose rotation is caused by the flame escaping from a series of cases arranged so as to form a contiuuous spiral.

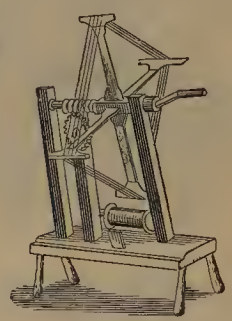
Fig. 7171.

*Flax Wheel, Card, and Reel.*

Fig. 7172.

"*Old-Time*" *Wool-Wheel.*

Fig. 7173.



*Knot-Reel.*

See under the following heads:—

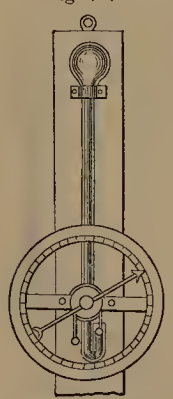
Aëro-hydro dynamic wheel.
Angular wheel.
Anuular wheel.
Anti-friction wheel.
Back-frame whcel.
Balance-wheel.
Band-wheel.
Barker's wheel.
Bastard wheel.
Bevel-wheel.
Brake-wheel.
Breast-wheel.
Brush-wheel.
Bucket-wheel.
Buff-wheel.
Burring-wheel.
Cam-wheel.
Canting-wheel.
Car-wheel.
Carriage-wheel.
Caster-wheel.
Center-wheel.
Center-discharge wheel.
Chain-wheel.
Change-wheel.
Chapelet-wheel.
Circumferentor.
Click-wheel.
Cloth-wheel.
Cog-wheel.
Conical wheel.
Contrate-wheel.
Count-wheel.
Crank-wheel.
Crown-wheel.
Current-wheel.
Cylinder-wheel.
Danaide.
Dash-wheel.
Dial-wheel.
Disk-wheel.
Double-gear wheel.
Downward-discharge wheel.
Driver.
Driving-wheel.
Drum.
Eccentric.
Eccentric wheel.
Edge-wheel.
Elliptical wheel.
Emery-wheel.
Emery-vulcanite wheel.
Epicycloidal wheel.
Escape-wheel.
Face-wheel.
Fan-wheel.
Feed-whcel.
Fifth wheel.
Flash-whcel.
Flush-wheel.
Flutter-wheel.
Fly.
Fly-wheel.
Follower.
Frictiou-wheel.
Fuzee.
Gage-wheel.
Gear-wheel.
Gin-wheel.
Glazer.
Glazing-wheel.
Going-wheel.
Grain-wheel.
Grinding-wheel.
Ground-wheel.
Grooved wheel.
Hand-wheel.
Heart-wheel.
Horizontal water-wheel.
Idle wheel.
Intermittent wheel.
Internal wheel.

Irregular wheel.
Lantern-wheel.
Lap.
Lapidary's wheel.
Leader.
Leading-wheel.
Mangle-wheel.
Master-wheel.
Match-wheel.
Measuring-wheel.
Meter-wheel.
Mill-wheel.
Minute-wheel.
Miter-wheel.
Mortise-wheel.
Multiple-wheel.
Multiplying-wheel.
Mutilated wheel.
Non-circular wheel.
Noria.
Odometer.
Outrigger.
Overshot-wheel.
Paddle-wheel.
Pendulum-wheel.
Persian wheel.
Pinion.
Pin-wheel.
Pitch-back wheel.
Pitch-wheel.
Planet-wheel.
Plate-wheel.
Plow-wheel.
Polishing-wheel.
Potter's wheel.
Pot-wheel.
Printing-wheel.
Propeller-wheel.
Pulley-wheel.
Racket-wheel.
Rag-wheel.
Ratchet-wheel.
Reaction-wheel
Rowel.
Scape-wheel.
Scoop-wheel.
Screw-wheel.
Scroll-wheel.
Sector-wheel.
Segment-wheel.
Skew-wheel.
Skew-bevel wheel.
Slicer.
Slosh-wheel.
Snail-wheel.
Speed-cones.
Spider.
Spike-wheel.
Spinning-wheel.
Spiral wheel.
Sprocket-wheel.
Spur-wheel.
Star-wheel.
Starting-wheel.
Steam-wheel.
Steering-wheel.
Stepped-wheel.
Stitch-wheel.
Stream-wheel.
Sun and planet wheels.
Swash-plate.
Swing-wheel.
Tappet-wheel.
Tempering-wheel.
Tide-wheel.
Tiller-wheel.
Tobacco-wheel.
Traction-wheel.
Trammel-wheel.
Tread-wheel.
Troll-plate.
Truckle.
Trundle-wheel.
Tub-wheel.
Turbine-wheel.
Tympanum.
Undershot-wheel.
Urchin.
Variable-wheel.
Volute-wheel.
Wabbler.
Walking-wheel.
Wallower.
Warning-wheel.
Water-wheel.
Waved wheel.
Web-wheel.
Wheel and axle.
Wheel-annealing furnace.
Wheel-barometer.
Wheelbarrow.
Wheel-chair.
Wheel-cotter.
Wheel-cultivator.
Wheel-cutting machine.
Wheel-jack.
Wheel-lathe.
Wheel-lock.
Wheel-pit.
Wheel-plow.
Wheel-press.
Whim.
Whirling-table.
Wind-wheel.
Wiper.
Wire-wheel.
Worm-wheel.

**Wheel and Ax'le.** This is cited as one of the mechanical powers. It is an application of the lever, in which the action is continuous. See WELL-BUCKET ELEVATOR.

Rejecting the consideration of friction, the power and effect are proportioned to the radii of the respective barrels. 1 pound on the cord which passes over the wheel of 4 feet radius will balance 8 pounds on the end of the cord which is wound on the axle having a radius of 6 inches. A small weight or power may be applied on the rope running over the wheel, moving at relatively high speed, to raise, at a proportionately slow speed, a heavy weight on the rope which winds upon the axle; or, conversely, a heavy weight or relatively great power on the axle-rope may raise with speed a light weight attached to the wheel-rope.

Fig. 7174.



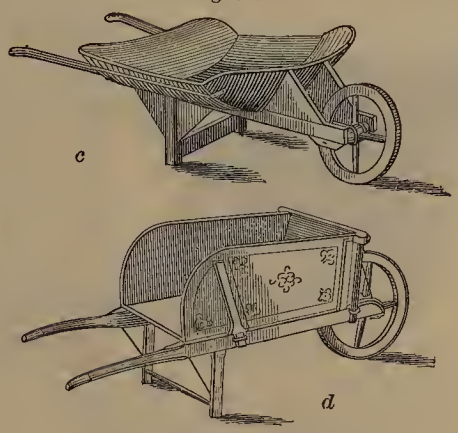
*Wheel-Barometer.*

**Wheel-an-neal'ing Fur'nace.** A furnace constructed for annealing cast-iron car-wheels. See Figs. 243–246, page 113.

**Wheel-ba-rom'e-ter.** One in which the fluctuations of the hight of the mercurial column are conveyed by float and cord to an axis on which is a pointer traversing a graduated circle. See BAROMETER.

**Wheel'bar-row.** There are many varieties of wheelbarrows. The most efficient implement for removing excavated earth, as in railway-grading, is the barrow with a scoop-shaped bed (*c*). It has a small wheel, widely diverging handles, and is adapted to dump on either side.

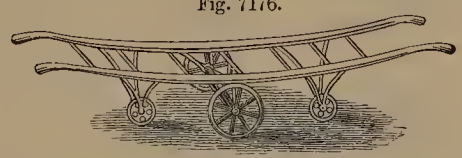
Fig. 7175.




*Grading and Garden Barrows.*

The *garden*-barrow (*d*), with removable sides, is more convenient about a farm or garden for the multitudinous uses which occur.

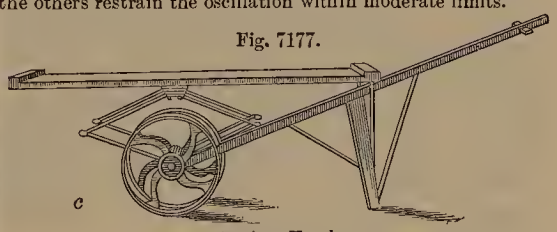
Fig. 7176.



*Express-Wheelbarrow.*

The express-wheelbarrow (Fig. 7176) is a superior form of the warehouse-barrow, adapted to carry heavy loads on a floor. The load may be balanced on the middle pair of wheels, and the others restrain the oscillation within moderate limits.

Fig. 7177.

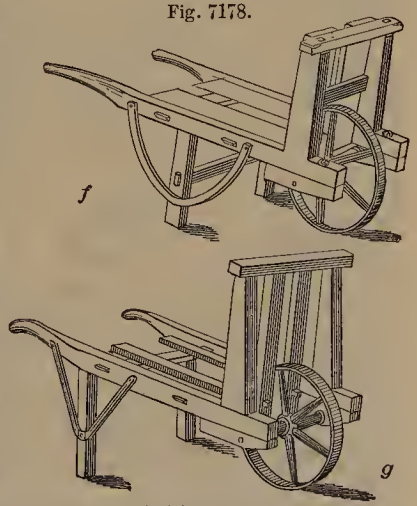



*Spring-Truck.*

*f* (Fig. 7178) is a green-brick barrow.
*g*, a dry-brick barrow.
*h*, Fig. (7179) a dumping-barrow.
*a* and *b* (Fig. 7180) are varieties of barrows for porterage and wheeling long stuff.

M. le Duc corrects an error that has prevailed in France with regard to the invention of this useful little vehicle. It has been attributed to M. Dupin, who, it has been claimed, devised it in 1669. M. le Duc says he found mention of them in the thirteenth, fourteenth, and fifteenth century MSS., and gives an illustration taken from a vignette of a MS. of the thirteenth century, of a man propelling a wheelbarrow, the form of which differs but slightly from those now in use.

Fig. 7178.




*Brick-Barrows.*

The Chinese wheelbarrow has but one wheel, but it is large, and placed in the center of the

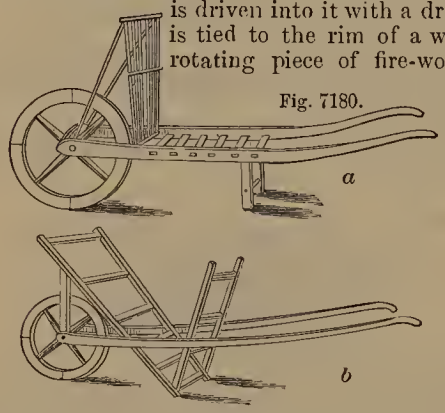
bed of the vehicle; the entire load rests on the central wheel. In Shanghai, thousands of these vehicles ply for hire. The usual load is two persons, who sit on a wooden platform on each side of the wheel, resting one arm each upon the framework which rises above the top of the wheel, and planting one foot in a stirrup made of rope.

Fig. 7179.

*Dumping-Barrow.*

**Wheel-case.** (*Pyrotechnics.*) A stout paper case, similar to a rocket-case or sun-case. It is filled with composition, which is driven into it with a drift, and is tied to the rim of a wheel or rotating piece of fire-works, to

Fig. 7180.




*Wheelbarrows.*

which it imparts a circular motion, at the same time emitting brilliant trains of fire. (See WHEEL, 4.) The following compositions are employed:—

*Brilliant;* 1 niter, 1 sulphur, 16 mealed powder, 7 cast-iron filings.

*Chinese;* 2 niter, 1 sulphur, 16 mealed powder, 4 charcoal.

*White;* 6 niter, 7 sulphur, 16 mealed powder.

**Wheel-chair.** A *bath-chair*, or invalid chair.

The *chiramaxium* or *gestatoria sella* of the ancients. A small carriage for one person, drawn by slaves.

In the Middle Ages the lame used chairs on casters.

**Wheel-col'ter.** A sharp-edged wheel running in advance of the breast of the plow, to cut the sod or weeds in the line of the furrow. It has long been used in the fen-lands of England. See Fig. 1391, page 596.

**Wheel-cul'ti-va-tor.** One traveling on wheels during its work. See figures, page 657.

**Wheel-cut'ting Ma-chine'.** Invented by Dr. Hooke for cutting the cog-wheels of watches, about 1655. See page 960. See GEAR-CUTTER, Fig. 2205.

**Wheel-draft.** In steam-boilers, when the current of smoke and hot-air is continued round and round in the same direction. In contradistinction to a *direct*, a *reverting*, or a *split* (i. e. divided) *draft*. Usual in the *wagon* boilers.

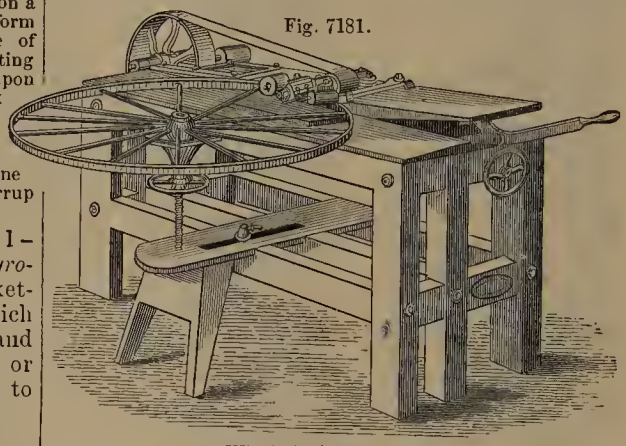
**Wheel-fac'ing Ma-chine'.** A machine for facing the sides of wheels, reducing the fellies to a uniform thickness, and beveling them if desired.

The fellies, having been driven on the spokes, the hub of the wheel is placed in a self-centering chuck, which is raised and lowered, by a screw and hand-wheel, to give the desired bevel to the side. The table carrying the chuck is adjustable for wheels of different diameters. The cutter-head frame and table, to which pressure rollers are attached, are elevated by a lever when a wheel is to be placed under the cutters or taken out. The cutter-head and rolls have minute adjustment by means of a hand-wheel and screw.

**Wheel-fin'ish-ing Ma-chine'.** A machine-tool for planing off the inside of the tires of locomotive-wheels. It may be called a curvilinear slotting-machine, the tool being mounted on a holder at the end of a vibrating lever.

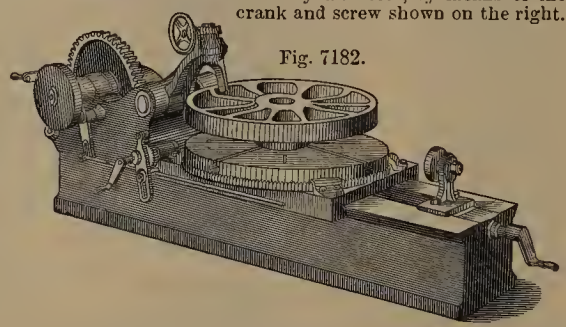
The other end of this lever is slotted and fitted with a sliding block, into which the pin of a disk-crank enters. As the crank-disk revolves with its upper edge approaching the fulcrum of the lever, the tool-holder receives a slow downward and a quick return stroke. The point of the tool describes an arc of a circle struck from the center of the vibration of the lever, thereby producing a convex form on the inside of the tire. The wheel bed-plate is revolved by automatic mechanism somewhat similar to the devices ordinarily employed in planing-machines. Provision is made for wheels of any diameter, by means of the crank and screw shown on the right.

Fig. 7181.



*Wheel-Facing Machine.*

Fig. 7182.

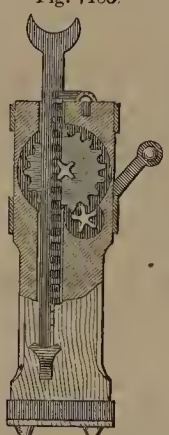


*Webb's Wheel-Finishing Machine (English).*

**Wheel-guard Plate.** (*Ordnance.*) An iron plate on each side of the stock of a field or siege gun-carriage to prevent its being chafed by the wheels when turning. Used also on carriages.

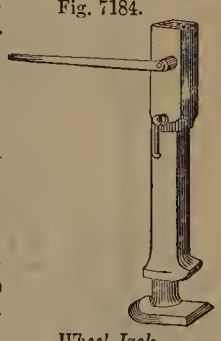
**Wheel-jack.** 1. The *lifting-bar* is a cogged rack operated by a pinion and hand-crank through the intervention of gearing, by which the power is multiplied. See also LIFTING-JACK.

Fig. 7183.



*Section of Wheel-Jack.*

Fig. 7184.



*Wheel-Jack.*

2. A lifting-jack with a low toe, to catch beneath the tire of a wheel.

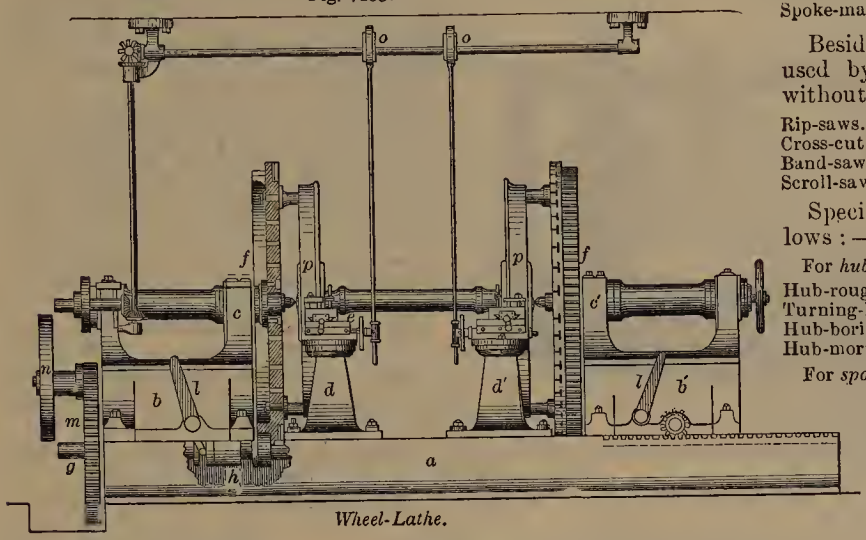
The illustration (Fig. 7184) shows a hydraulic jack thus adapted. See also LIFTING-JACK, and list under JACK.

**Wheel-lathe.** A lathe for turning railway-wheels and other large work.

*a* (Fig. 7185), base-plate.

*b b'*, standards for carrying head-stocks, *b* being permanent

Fig. 7185.




*Wheel-Lathe.*

and $b'$ movable on the base-plate by means of a rack and pinion.

*c*, fast, and *c'*, movable head-stock, the center in which can be moved out any distance as in an ordinary puppet-head.

*d d*, standards for carrying slide-rests.

*e e*, compound slide-rests.

*f f*, large face-plates, with extra wheels at back.

*g*, longitudinal shaft.

*h*, one of two pinions keyed on shaft *g*, and gearing into the external wheels *f f*.

*l*, clutches for disconnecting the pinions from the external wheels.

*m*, spur-gearing at end of lathe.

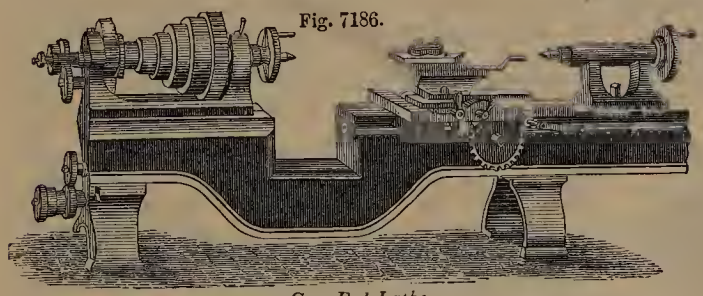
*n*, strap-pulley.

*o o*, apparatus for giving self-acting motion to the two compound slide-rests.

*p p*, wheels to be turned.

Fig. 7186 is called a *gap-bed* lathe, having a cavity in the bed enabling objects to be turned the diameter of which is greater than the distance between the center and the sheers.

Fig. 7186.



*Gap-Bed Lathe.*

**Wheel-lock.** 1. (*Fire-arms.*) A form of lock for fire-arms which superseded the old matchlock, whereby the piece was touched off by a match or port-fire.

The wheel-lock was invented in Italy early in the sixteenth century; it was moved by a chain and wound up like a watch to prepare it for use. The wheel, originally, was not fixed in the gun, but was fitted in a groove when ready for firing; at other times being carried in a bag. It consisted of a furrowed wheel of steel, whose friction against a piece of sulphuret of iron was made to communicate fire by sparks to the priming. See GUN-LOCK.

2. (*Locksmithing.*) A form of lock having a series of wheels or disks with letters around their edges. The interior arrangements of the lock were such as to prevent the bolt being shot until a series of letters were in line, forming a combination known only to the owner and maker. See LETTER-LOCK.

3. A wagon-lock, to retard the revolution of the wheels in descending a hill.

**Wheel-ma-chin'er-y.** It is but of late years that the making of carriage and wagon wheels has been so systematized as to call for specific machines for the various operations. These may be classed as, —

Hub-machines. Felly-machines.
Spoke-machines. Wheel-makers.

Besides these, the following are used by wheel-makers, with or without special adaptation: —

Rip-saws. Surfacing-planers.
Cross-cut saws. Boring-machines.
Band-saws. Turning-lathes.
Scroll-saws. Tenoning-machines.

Special machines are as follows: —

For *hubs*: —

Hub-rougher.
Turning-lathe.
Hub-boring machine.
Hub-mortising machine.

For *spokes*: —

Center-sawing machine.
Spoke-lathe.
Spoke-tenoning machine.
Spoke-throating machine.
Spoke-sizing machine.
Tenon-truing machine.
Sand-belt machine.
Oval tenon forming-machine.

For *fellies*: —

Bevel felly-planing machine.
Inside and face planer.
Felly cutting-off saw.
Felly-rounder.
Felly-boring machine.
Felly-doweling machine.

For *setting up and finishing wheels*: —

Spoke-driving machine.
Wheel-facing machine.
Wheel-screwing machine.

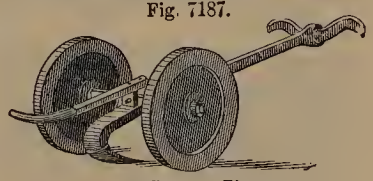
**Wheel-mold'ing Ma-chine.** (*Founding.*) A machine for making the mold for gear-wheels by repeating a section of a few cogs around the perimeter. See Fig. 3202, page 1468.

**Wheel-pit.** A walled hole for the heavy fly-wheel of a train of rolls, etc.

**Wheel-plow.** 1. A plow supported in part by a wheel or wheels as a gage of depth. See Figs. 3823 – 3825, pages 1745, 1746.

2. A plow with a wheel in the space between the landside and mold-board, and reducing the friction of the plow by bearing the weight. See *f*, Fig. 3823; see also B and C, Fig. 3825, page 1746.

Fig. 7187.

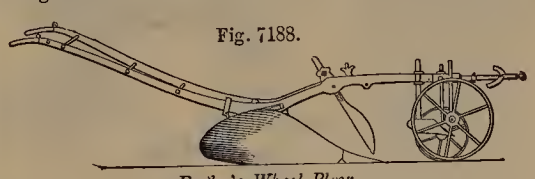


*Roman Plow.*

A Roman wheel-plow is illustrated in the accompanying cut, and needs no particular description.

Busby's wheel-plow (English) received the Council Medal in its class at the London Exhibition of 1851. It is mentioned in an English treatise as the best specimen of a plow that is manufactured. It has land and furrow wheels, a skim colter, and is principally or altogether of iron.

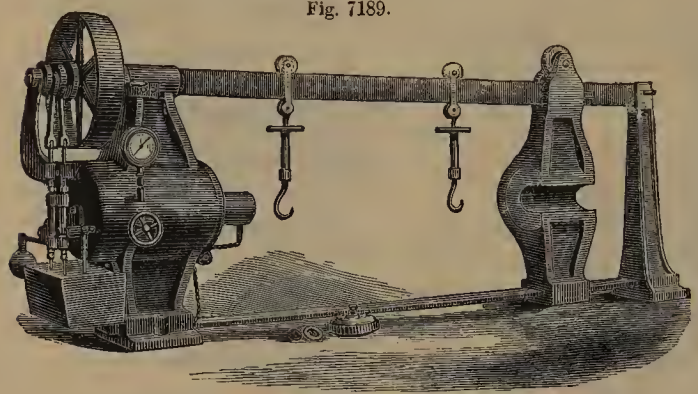
Fig. 7188.



*Busby's Wheel-Plow.*

**Wheel-press.** 1. A hydrostatic press for forcing car-wheels on to their axles and removing them. The axle is suspended from the hooks, and one end passed through the groove in the slotted post, which resists the thrust of the ram, and is held at any desired position by a key or otherwise. The ram is operated by a double-acting pump, and may be

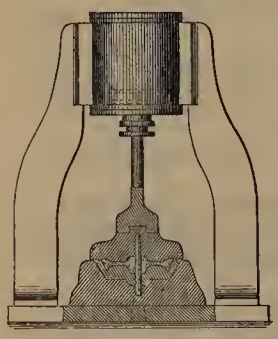
Fig. 7189.



*Hydraulic Car-Wheel Press (N. Y. Steam-Engine Co.).*

worked up to a pressure of 5,000 pounds per square inch.

Fig. 7190.



*Wheel-Molding Press.*

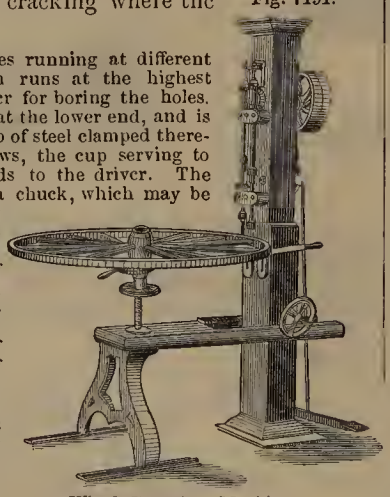
2. A press in which car-wheels are molded. The *drag* is suspended from the piston of a hydraulic press, and is forced down upon the *cope*. A central spindle makes a tapering hole in the nave, and acts as a guide.

**Wheel-quar'ter-ing Ma-chine'.** A machine for quartering locomotive driving-wheels on their axles, that is, boring the wrist-pin holes at 90° distance apart. See QUARTERING-MACHINE, page 1842, Fig. 4067.

**Wheel-rope.** (*Nautical.*) One connecting the steering-wheel with the tiller.

**Wheel-screw'ing Ma-chine'.** A machine for boring the holes and fixing the screws in the rims or fellies of wheels to prevent them from splitting or cracking where the spokes enter.

Fig. 7191.



*Wheel-Screwing Machine.*

It has two spindles running at different speeds. That which runs at the highest speed carries an auger for boring the holes. The other is cupped at the lower end, and is split to receive a strip of steel clamped therein to drive the screws, the cup serving to guide the screw-heads to the driver. The wheels are held in a chuck, which may be raised or lowered by a screw and hand-wheel to suit different lengths of hubs, and brought to or from the machine to accommodate different sizes of wheels by means of a rack and pinion. The belt which drives the boring-spindle is slack enough to allow the spindle to stop when the foot is taken off the treadle. The other spindle runs constantly with the countershaft.

**Wheel-spok'ing Ma-chine'.** A machine for driving spokes symmetrically. See SPOKE; SPOKE-MACHINES; etc.

**Wheel-spoke Plan'ing-ma-chine'.** A machine-tool for planing the faces of spokes of locomotive-wheels.

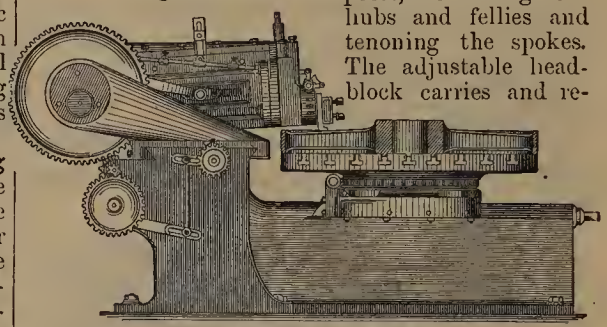
The tool traverses at an angle from the horizontal, allowing for the increased thickness of metal near the hub. The tool-holder is at the outer end of a reciprocating ram, which works on guides formed on a plate adjustable at any angle, so as to conform to the taper of the spoke. The wheel is dogged to a table, which has a circular adjustment to present each spoke in turn to the planer-tool.

The tool-holder at the end of the ram is adjustable vertically, and is provided with a toothed arc actuated by a worm, and so arranged that the point of the tool can be made to traverse automatically on the arc of a circle. In this way the desired rounded form can be given to the edges of the spokes. The motion is given to the ram by a crank of adjustable throw in the ordinary way, and the carriage on which the ram is mounted is also capable of being traversed along its bed by self-acting gear.

**Wheel-turn'ing Lathe.** One with two very solid head-stocks with large face-plates, and two slide-rests operated by a ratchet-feed from an overhead rock-shaft. The arrangement of the parts is such that the pressure in cutting always falls within the surface of the bed. See WHEEL-LATHE.

**Wheel'wright's Ma-chine'.** A machine adaptable to several purposes, as boring the hubs and fellies and tenoning the spokes. The adjustable head-block carries and revolves the auger. The stuff is held in place and fed to the operating-tool by a spring-clamp and sliding-carriage.

Fig. 7192.



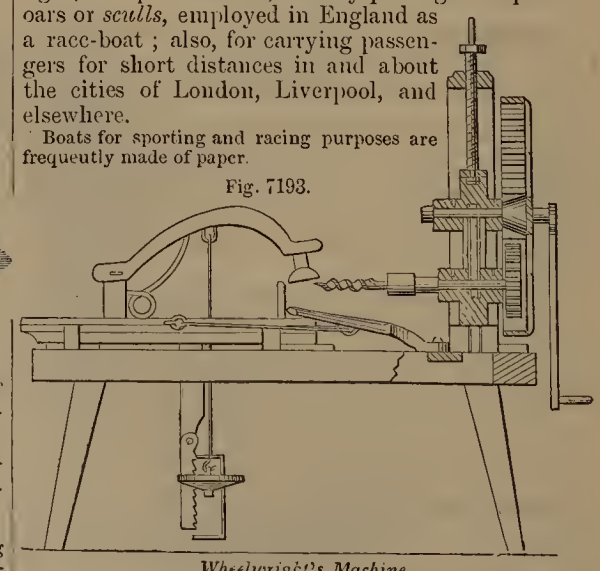
*Wheel-Spoke Planing-Machine.*

**Whelp.** (*Nautical.*) One of the inclined bars on a capstan or windlass, upon which the hawser or cable is wound. The messenger or hawser takes two or three turns round the barrel, the whelps forming a skeleton frustum; the conical form is to cause the cable to *fleet* back to the smaller portion as it winds, to prevent its becoming jammed against the pawl-head at the large end. See CAPSTAN, Fig. 1083.

**Wher'ry.** Corrupted from the Roman *horia*. A light, sharp-built boat, usually pulling one pair of oars or *sculls*, employed in England as a race-boat; also, for carrying passengers for short distances in and about the cities of London, Liverpool, and elsewhere.

Boats for sporting and racing purposes are frequently made of paper.

Fig. 7193.



*Wheelwright's Machine.*

The following is a description of one constructed for Walter Brown, the celebrated oarsman, after the Waters patent, from a model of his own. This boat is 31½ feet long, 12 inches wide, and weighs but 22 pounds. The lightest wooden boat ever built of similar dimensions weighed 41 pounds. The most singular part of the matter is that the boat is more than four times stronger than one of wood. All of it, save where the sculler sits, is gas-tight, so that in the event of a race sufficient gas may be taken into it to reduce its weight to 8 pounds. The displacement of water by such a craft will be very much less than that of a wooden boat, and the same exertion will propel it proportionately faster. Its strength is also a great advantage.

**Whet'stone.** A piece of stone, usually a rectangular slab, used for sharpening cutlery or tools. Scythe-stones are, however, bellied, and taper toward the ends.

Many varieties of stone, especially of the slaty kinds, are more or less perfectly adapted for the purpose. Some, however, are peculiarly suited for imparting a fine edge to tools, command a high price, and are generally used in the workshop as oil-stones. See OIL-STONE; HONE; GRINDING and POLISHING.

The best known locality in the country for whetstone or *novaculite* is about two miles from the hot springs in Arkansas. It is quarried in blocks from two to four feet square, or in irregular masses which are afterward split into slabs. This is generally known as Ouichita-stone.

Another variety, termed white-stone, is also derived from the Arkansas quarry. It is of much finer grain than the preceding kind, and is used by jewelers, engravers, and surgical-instrument makers for sharpening their implements; and also for sewing-machine needles.

Another variety, known as Hindostan stone, is derived from a quarry in Orange County, Indiana.

"In ancient times," says Pliny (*d.* A. D. 79), "the only whetstones known were those of Crete and other places beyond sea, and they only used oil to sharpen the scythe with [and a file probably]. For this purpose the mower moved along, with a horn to hold the oil fastened to his thigh. Italy has since furnished us with whetstones which are used with water and give an edge to the iron quite equal to that imparted by the file; these water-whetstones, however, turn green very quickly."

Laconia was also famous for its oil-stones.

A celebrated deposit which exists near Constantinople has been quarried for centuries, and furnishes the well-known *Turkey oil-stones*.

An ancient hone found in a British barrow was a blue-gray stone 3″ by 1″, and ¼″ thick.

Whetstones for farmers', mechanic's, and domestic use are ground on a horizontal wooden wheel studded with scraps of nail-plate. Sand and water are used for smoothing them. The wood wears more rapidly than the iron, and leaves the latter somewhat salient. It is said to exceed a cast-iron plate in effectiveness, three to one.

**Whet'ter.** A sharpener; as a whetstone, hone, rifle, steel, strap, etc. See list under GRINDING and POLISHING, page 1017.

**Whif'fle-tree.** A bar to which the traces of an animal's harness are connected, and whereby the vehicle is drawn. A *whippletree*. The terms *single*, *double*, and *treble tree* are more convenient, and expressive of their capacity. See SINGLE-TREE; DOUBLE-TREE; TREBLE-TREE.

**Whim.** (*Mining.*) A large winding-wheel for the rope of a mine-shaft. See WHIN.

**Whim'ble.** (*Mining.*) A hollow instrument for cleaning the rubbish out of a bore-hole. *Wimble.*

**Whim-rope.** (*Mining.*) A rope by which the kibble is attached to the winding-engine or whim.

**Whim'sey.** 1. (*Mining.*) An engine used to draw up coals; the term is particularly applied to the old atmospheric engines.

2. A small warehouse-crane for lifting goods to the upper stories.

**Whim-shaft.** (*Mining.*) The shaft by which the stuff is drawn out of a mine.

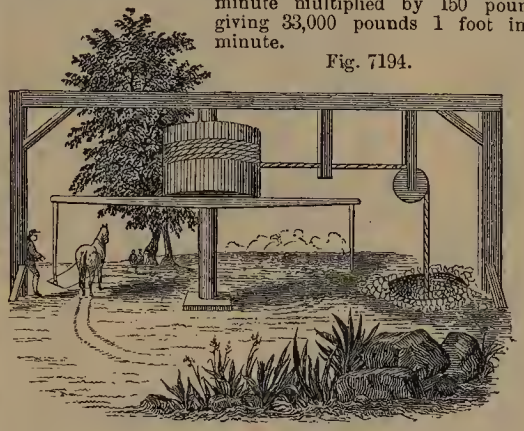
**Whin.** (*Mining.*) *a.* Any very hard stone.

*b.* Sometimes written *whim.* A hoisting-device operated by horse-power to wind a rope and draw a kibble or bucket from a mine.

The rope is passed over a pulley and around a drum on a vertical shaft provided with a cross-bar, to which a pair of traces is connected.

To exercise the best effect, the track should not be less than 24 feet in diameter, and the horse should walk at the rate of 2½ miles per hour. Exerting a force of 150 pounds at that rate for 8 hours is equal to a horse-power, — the speed 220 feet in a minute multiplied by 150 pounds giving 33,000 pounds 1 foot in a minute.

Fig. 7194.



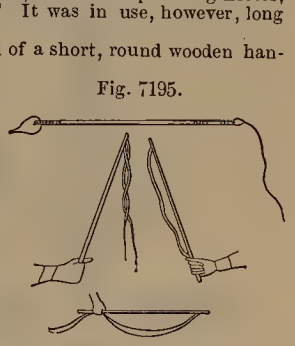
*Whin.*

**Whip.** 1. (*Saddlery.*) An instrument used for driving horses and other animals, or for correction; commonly consisting of a handle, a thong of plaited leather, and a lash of plaited hemp or other fiber. Frequently, however, the handle and thong are in one, forming a tapering flexible rod; riding-whips are made in this way.

The device is very ancient, being referred to in Proverbs xxvi. 3, and Nahum iii. 2. "The noise of a whip, and the noise of the rattling of the wheels, and of the prancing horses, and of the jumping chariots." It was in use, however, long before this.

The Egyptian whip consisted of a short, round wooden handle, and a single or double thong about 2 feet in length, twisted or plaited. A loop was attached, so that it could be swung from the left wrist while the archer was using his bow. Short, knotted whips, much resembling our riding-whips and the postilions' whips of the last and the early part of the present century, are also shown in the paintings of Thebes.

Fig. 7195.



*Egyptian Whips (from Thebes).*

The whips of the ancients generally had knots or bronze or leaden (*plumbatum*) balls on the lashes to render them more severe. The priests of Cybele punished themselves with whips on whose lashes were the *astragali* bones of kids. Greek whips were of leathern thongs, twisted cords of hog's bristles, or sinews of oxen. The *scorpio* was a whip with iron spurs. The Anglo-Saxon whip for prisoners was three-lashed. Switches were used for soldiers.

Eel-skins were used to flog school-boys by the Romans and Anglo-Saxons.

The ancient Scythian whip resembled the *nogaik* of the modern Cossacks. It had a short handle and a single lash, with a round flat piece of leather at the end. The taskmasters of Egypt and Persia hurried up their workmen with whips. Xerxes lashed the laborers who dug the canal across the isthmus of Athos; and his soldiers were hurried by whips across the Hellespont bridge, during the 7 days and nights which they occupied in crossing between Abydos and a rocky point in the Hellespontine Chersonese. The bridge was about 1½ miles long.

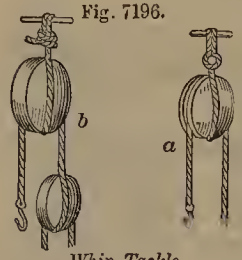
The artillery-driver's whip has an interior stock of raw hide covered with India-rubber cloth, over which is sewed an outer covering of leather. A loop is attached at the but for suspension. A lash of thread is attached to the small end.

Fancy whips are made with handles composed of a central core of whalebone stiffened and filled out with rattan; this is inclosed in rubber cloth and covered with rubber cement, over which strands of cotton, silk, or gut are braided by machinery.

2. (*Nautical.*) *a.* A form of hoisting-tackle. A single whip (*a*, Fig. 7196) is the most simple purchase in use. It is made by reeving a rope through a single block.

If the fall of the rope of a single whip be spliced round the block of another whip, it becomes *whip on whip* (*b*) or *whip and runner.* Thus two single blocks afford the same purchase as a tackle having a double and a single block, with much less friction. For other varieties of purchase, see TACKLE.

Fig. 7196.




*Whip-Tackle.*

In unloading colliers in the Thames, the bucket of coal is raised by a *whip*, a number of cords attached to the fall being grasped by as many men, who mount a wide ladder, and after two or three hauls at the rope, jump to the deck and *whip* up the bucket to the landing, where it is dumped.

A modified form of this whip is one in which the fall is attached to a platform which slides up and down a ladder. The man ascends the ladder, steps on to the platform, which descends with his weight and raises the cask or chest. It is rigged where a large number of pieces of the same size are to be raised, as salt or coffee in bags, flour in barrels, tea in chests.

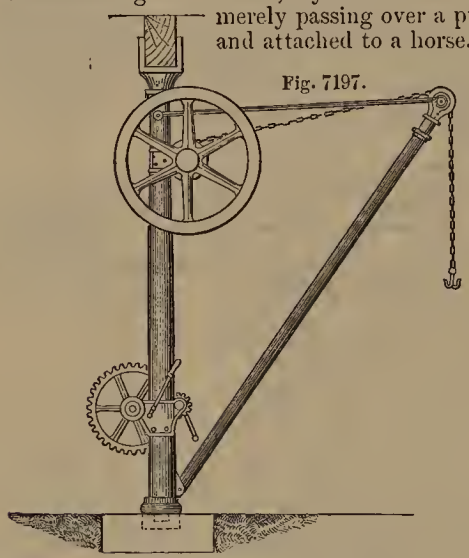
*b*. A flag used for signaling.

3. The arm of a windmill, on which a sail is extended.

4. To sew over and over, as the two selvages of stuffs stitched together. As we say, *whip* them together merely ; or *whip* them down.

**Whip and Der'ry.** (*Mining.*) An arrangement for raising the kibble, by means of a rope merely passing over a pulley and attached to a horse.

Fig. 7197.

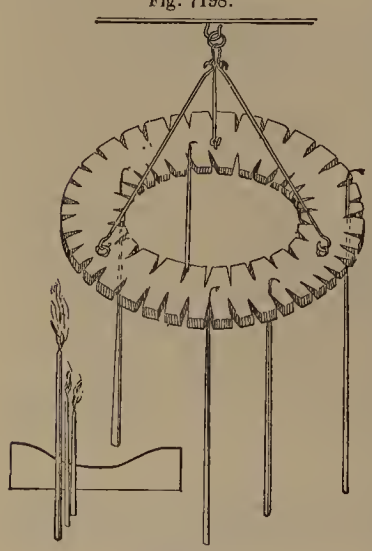


*Pillar or Whip Crane.*

**Whip-braid'ing Ma-chine'.** See BRAIDING-MACHINE, Fig. 867.

**Whip-crane.** A crane of simple construction for *whipping* or quickly hoisting goods in unloading vessels.

Fig. 7198.



*Whip-Hanger.*

Fig. 7197 is a crane made with either iron or timber pillar and jib, and especially adapted for docks, warehouses, railway-stations, and all places where light and heavy weights have to be lifted alternately. It has three motions,—quick, medium, and slow. Light weights may be lifted at a quick speed by pulling directly at the rope ; for medium weights the handle is put on the rope-barrel shaft, and for heavy loads on the pinion-shaft. The speeds are rapidly changed, and the crane is made to swing completely round.

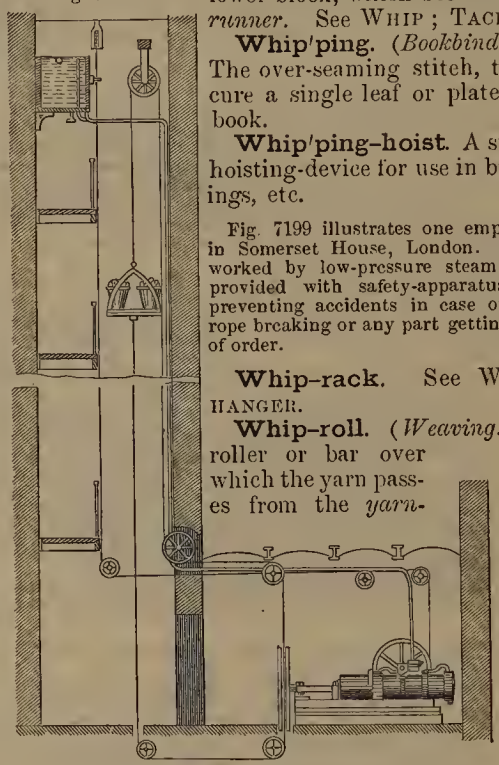
The crane has an efficient break, and is made secure to a beam at the top. See also CRANE, Fig. 1505, page 642, *et seq.*

**Whip-hang'er.** An annular rim or bracket provided with notches, into which the ends of the suspended whips fit.

**Whip-net.** A simple form of network fabric produced in the loom by a systematic crossing of the warps.

**Whip on Whip.** (*Nautical.*) A tackle consisting of two single blocks and falls ; the fall of the upper block is spliced round the lower block, which becomes the *runner*. See WHIP ; TACKLE.

Fig. 7199.



*Whipping-Hoist (Somerset House, London).*

**Whip'ping.** (*Bookbinding.*) The over-seaming stitch, to secure a single leaf or plate in a book.

**Whip'ping-hoist.** A steam hoisting-device for use in buildings, etc.

Fig. 7199 illustrates one employed in Somerset House, London. It is worked by low-pressure steam, and provided with safety-apparatus for preventing accidents in case of the rope breaking or any part getting out of order.

**Whip-rack.** See WHIP-HANGER.

**Whip-roll.** (*Weaving.*) A roller or bar over which the yarn passes from the *yarn-beam* to the *reed ;* by the pressure on the whip-roll, devices are brought into operation by which the rate of *let-off* is adjusted to the speed with which the weaving proceeds. See LET-OFF.

**Whip-saw.** A thin, narrow saw-blade strained in a frame, and used as a compass-saw in following curved lines. Of this class are the *buhl-saw* and *piercing-saw*.

**Whip-sock'et.** A pocket on the edge of the dash-board, to hold the whip.

**Whip up-on' Whip.** (*Nautical.*) One whip applied to the fall of another. See WHIP.

Fig. 7200.

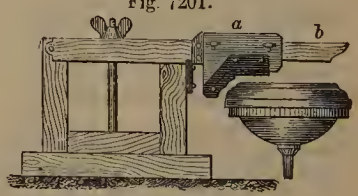
*Whip-Socket.*

**Whirl.** 1. A reel by which a strand of hemp or a gut is twisted in the process of manufacture.

2. A set of three spindles with hooks for yarn, and driven by a strap. A *rope-winch*.

**Whirl'er.** 1. One of the rotating hooks on which the end of a bunch

Fig. 7201.




*Whirling-Table.*

of hempen fibers is secured, and by which it is twisted into yarn as the man recedes backward from it, paying out the hemp as he goes. See ROPE-MAKING.

2. A revolving top, invented by Troughton, to serve as an artificial horizon.

**Whirl'i-gig.** A frame with wooden horses or seats on which persons are whirled around as an amusement. In the Middle Ages disorderly persons were punished by confinement in a cage which revolved on a pivot and made them sick.

**Whirl'ing-ta'ble.** (*Pottery.*) A horizontal disk rotating in a horizontal plane and carrying a plaster mold, whose surface is the counterpart of the inside of the plate, saucer, cup, or other circular object, while the outer surface of the object is formed by the templet, which is lowered upon and gaged for the thickness of the ware (Fig. 7201).

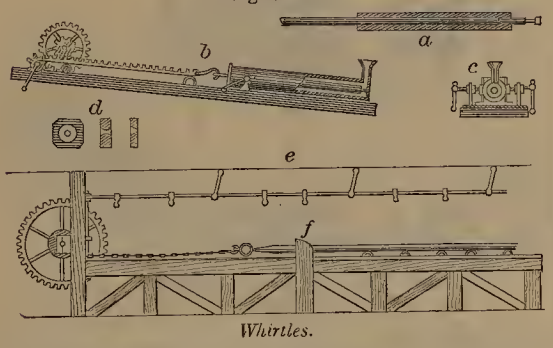
The templet *a* moves in or out upon an arm *b* according to the radial dimensions of the ware to be molded, and descends in a groove to a distance regulated by a stop in correspondence to the desired thickness of the ware. The molds are made of plaster, and as they readily absorb moisture, they are kept in a drying-room, from whence they are brought by a boy as required.

The plate-maker cuts off a piece of clay with a wire, and flattens it out by a plaster-mallet called a *batter*, while the clay rests upon a slab of wet plaster called a *batting-block*. A boy brings a plaster-mold from the drying-room, places it on the whirling-table, and then takes his position at the driving-crank. The man places the clay on the mold which forms the inside of the vessel, and when motion is imparted to the table the templet *a* is brought down and gives the required thickness and configuration to the ware. The mold and the ware are then removed to the drying-room, where, in a few hours, the plate is sufficiently dry to be removed from the mold. The latter is left to dry for a while longer, to remove the moisture contracted from the clay.

**Whir'tle.** A perforated steel plate through which pipe or wire is drawn to reduce its diameter.

Fig. 7202 illustrates a mode of forming lead-pipe. *a* is a section of the mold in which the rough tube is cast upon a treblet serving as a core. This is placed in an inclined position, as at

Fig. 7202.




*Whirtles.*

*b*, the pouring being done at the lower end. The core is enlarged at the lower end, so that when the other is made fast to the rack and the gear operated, the pipe is drawn with it through the whirtle. *c* is a section illustrating the plan of clamping the mold. *d* are a plan and two sections of a whirtle. *e* is a drawing-machine in which a chain, winding upon a shaft rotated by gearing operated from the engine, is engaged to the treblet, drawing it over rollers through the whirtle at *f*. The whirtles are made rounded on one side to allow the more ready exit and entry of the pipe. They are of various sizes, the pipe being drawn through the larger ones first, and afterward through the smaller, of the gradually decreasing series, until reduced to the proper size.

**Whisk.** 1. A small besom of broom-corn.

2. An egg-beater.

3. A cooper's plane.

**Whisk'er.** (*Nautical.*) Projecting booms at the bows, to spread the guys of the jib-boom.

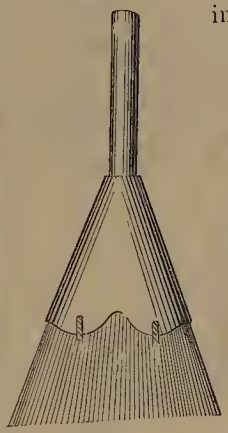
**Whis'ket.** 1. A small lathe, used for turning wooden pins. It has a hollow chuck, which holds the pin while turning.

2. A *basket*.

**Whis'key.** Corrupted from *kibitka*, or *britschka*. See BRITZSKA.

**Whis'per-ing-gal'ler-y.** One of circular plan, in which a faint sound conveyed around the interior wall may be readily heard, while the same is inaudible elsewhere in the interior.

Fig. 7203.

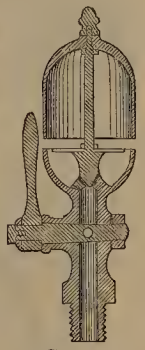


*Whisk.*

Fig. 7204.

*Police Duplex Calls, with Guard.*

Fig. 7205.



*Steam-Whistle.*

Mentioned by Seneca, and well known to the ancients.

**Whis'tle.** 1. A shrill-toned wind-instrument, used as a child's toy. Larger instruments of the kind are employed as alarms and for signaling.

Fig. 7204 is a duplex whistle, for policemen, street-railroad car-starters, etc. It has two tubes of different lengths and consequent pitch.

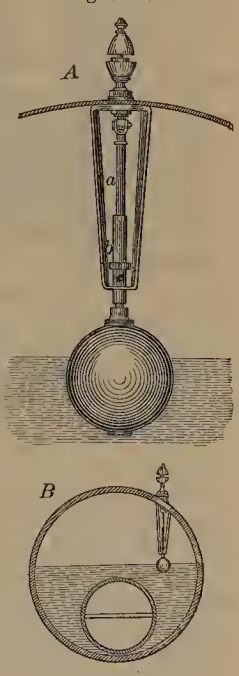
The only musical instruments exhumed from the prehistoric deposits are whistles and pipes: one of the former obtained in a cavern of the Department of Dordogne in France is the first digital phalanx of a reindeer, with a cylindrical smooth-drilled hole. It yet yields a shrill sound when blown into. Several whistles made of the eye-teeth of dogs, with holes drilled near the roots, have been found in the cave of Lombrive, Department of Ariège. These are contemporary with the remains of the rhinoceros, reindeer, mammoth, hyena, bear, and cave-lion. A pipe with three finger-holes, made from a fragment of stag-horn, was found in the vicinity of Poitiers.

An ivory whistle a foot long has been found in a British barrow. It is engraved in Grose.

The railway-signal code of the United States is, —

1 whistle, "down brakes."
2 whistles, "off brakes."
3 whistles, "back up."
Continued whistles, "danger."
Rapid short whistles, "cattle-alarm."
A sweeping parting of the hands on the level of the eye, "go ahead."
Downward motion of the hands with extended arm, "stop."

Fig. 7206.




*Whistles.*

2. The steam-whistle was invented in 1826 by Adrian Stephens, Plymouth, England.

It is attached to a pipe connected with the boiler. On turning a cock the steam enters the lower part of the case, and, striking against a thin-edged circular deflecting plate, is directed through an annular opening against the beveled rim of a hemispherical or elongated brass cup, and passes out between the upper and lower cups.

*A* (Fig. 7206) is Johnston's self-acting alarm-whistle. The rod *a* is adjustable in the tubular stem *b* of the ball, to suit the desired low-water level in the boiler. When the water falls below the fixed point, the descent of the ball opens a valve connected with the rod *a*, allowing steam to escape and sound the whistle.

*B* shows the device attached to a Cornish boiler.

See also LOW-WATER ALARM.

Porteous's whistle, for a railway or marine signal, consists of a single mouthpiece and a number of whistles of different tones arranged in the barrel. By the introduction of one discordant note, an extremely shrill vibra-

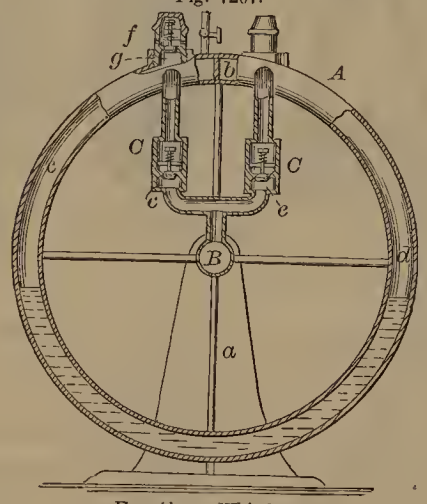
tion is produced, its peculiar dissonance rendering it distinctly audible over other sounds. (See also CALLIOPE.) The whistle, patent No. 46,910, March 21, 1865, gives also a variable sound.

Wood's railway-whistle (English patent, May 22, 1841) is attached to the blast-pipe to give a constaut intermittent whistle during foggy weather.

Fig. 7207 is a fog-alarm whistle, acting by the pulsation of water as the vessel sways, driving air out of an orifice.

The annular pipe *A* is divided into two chambers by a partition *b*. It is partially filled with liquid, and an oscillating motion is imparted to it, producing alternately a partial vacuum in each of the chambers *c d*, which is filled by air entering through downwardly openiug valves *g*, one for each chamber. The return oscillation, causing the liquid to rise,

Fig. 7207.




*Fog-Alarm Whistle.*

compresses the air, forcing it to pass through one of the downwardly opening valves *e e* in the pipes *C C*, whence it is discharged through the hollow trunnion *B* into a chamber to which the whistle is connected. See also FOG-ALARM, Fig. 2056, page 898.

Patent No. 13,639, January 21, 1868, is also for a whistle, operated by compressed air by means of a piston and hand-lever.

**White.** The white pigments of commerce are prineipally obtained from lead, but preparations of baryta and zinc are also nsed; the former as an adulteration, the latter as a substitute.

*White-lead* is the earbonate of lead, produeed from the metal. See WHITE-LEAD.

*Venice white* is a mixture of equal parts of white-lead and sulphate of baryta.

*Hamburg white* is lead, 1; baryta, 2 parts.

*Dutch white* has lead, 1; baryta, 3 parts.

*Clichy white* is pure carbonate of lead.

*Kremnitz white*, *krems white*, and *silver white* are synonyms of *white-lead*.

*Zinc-white*, an oxide of zinc. See ZINC-WHITE.

**White Brass.** An alloy of copper and zinc, with sufficient of the latter, or of nickel, lead, etc., to give it a white color.

| | Copper. | Zinc. | Nickel. | Iron. |
|---|---|---|---|---|
| *Tutenag* | 50 | 31 | 19 | .. |
| German white copper | 88 | .. | 8.75 | .. |
| Sorel's white brass (1840) | 10 | 80 | .. | 10 |
| *Packfong* | 5 | 7 | 7 | |
| Chinese packfong | 40.4 | 25.4 | 31 6 | 2.6 |
| | | | | Cadmium. |
| Parisian white metal | 69.8 | 5.5 | 19.8 | 4.7 |

**White-cloud Il-lu'mi-na'tor.** (*Optics.*) A reflector to illuminate a microscopic object with a subdued white light, such as is obtained from a bright *white cloud*. In place of a plane mirror, a surface of pounded glass or plaster of Paris is used.

**White Cop'per.** An alloy forming an imitation of silver: copper, 16; zinc, 1; with arsenic added in a small quantity, to whiten.

Known also as *white tombac* (Malay, *tambaga*, copper) or as *blanched copper*. See MOCK-SILVER; WHITE BRASS.

**White-lead.** Carbonate of lead ($PbO, CO_2$). A dense white powder, insoluble in water, but easily dissolved in dilute nitric or aeetic aeid; extensively employed in painting.

The dissolving of lead in vinegar to make a pigment was known to the aneients.

Various methods have been and are used in its manufacture.

By the Dutch process, generally employed in England, where the manufacture was introduced about 1780, metallic lead cast in star or circular shaped gratings 6 or 8 inches in diameter is placed in pots containing strong aeetic acid, over, but not in contact with, the acid. The pots are imbedded in a mixture of new and spent tan, and are covered with boards, over which is another layer of pots also imbedded in tan, and so on until a stack is built up some 20 to 25 feet in hight. The process is conducted within a covered chamber.

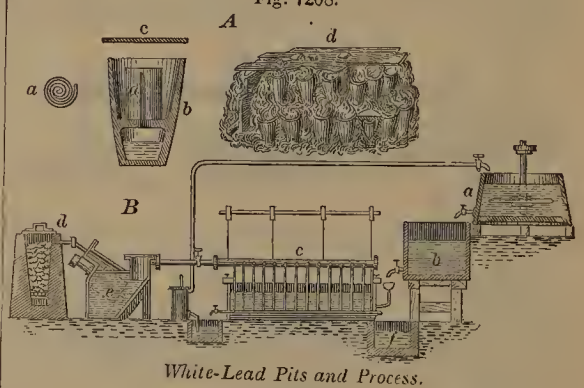
A double reaction takes place in consequence of the heat geuerated by the fermenting tan; the volatilized aeetic acid changes the metal into an acetate, which is converted into a carbonate by combination with the earbonic-acid gas evolved by the tan. The process occupies from 4 to 6 weeks.

In Franee, pits lined with masonry are constructed for the purpose. Stable-uanure is employed as the fermenting material. A similar plan is adopted in Hollaud, Belgium, and some parts of Germany. *a* (Fig, 7208, *A*) is a plate of cast-lead rolled into spiral form; this is placed on an annular ledge in the pot *b*, so as not to be in direct contact with the acetic acid, and the pot is covered with a leaden plate *c*; the stock of pots is arranged as shown at *d*.

It is of great importance that the lead should be pure, consequently sheet-lead is not used, cast-metal only being employed. Any iron gives the pigment a tawny hue; and if silver be present, it becomes dingy when exposed to the light.

Lead prepared in this way is afterward subjected to the aetion of a crushing-mill, and then passed through a separator, by which any remaining unconverted or "blue" lead is removed. It is then grouud in water, run through troughs arranged to arrest any metallic particles which may still remain; passed into tauks, where it is precipitated; and, finally, dried in large pans previous to being mixed with oil.

Fig. 7208.




*White-Lead Pits and Process.*

In the improved method, as practiced in England, the lead is first converted into litharge, which is mixed with a small proportion of the acetate of lead, and then subjected to the action of carbouic-acid gas, derived from the combustion of coke. In France, the process of Thénard and Roard is employed. Litharge is dissolved in aeetic acid, forming a solution of basic acetate of lead, through which a curreut of carbonic-acid gas is passed.

*B* is the apparatus employed at the works at Clichy. *a*, tub, provided with a stirrer, in which the litharge is dissolved; the acetate is drawn off into the tank *b*, where the impurities settle, and is then allowed to flow into the tubular decompositiou-vessel *c*, where carbonic-acid gas from the kiln *d*, filled with chalk $2\frac{1}{2}$, coke 1 part, is, after passing through the purifier *e*, conducted by the tubes to points uear the bottom of the liquid; when the process is complete, the supernatant neutral aeetate of lead is drawn off, and the white-lead, in the form of a semi-fluid magma, passes into *f*.

Sulphate of baryta is extensively used for the adulteration of white-lead. This substance is nearly as heavy as the lead, and is perfectly white, but not so brilliant. It has not the body of white-lead, but is not so easily affected in color by noxious gases, white-lead being soon discolored hy sulphureted hydrogen gas.

The carbonate of zlue is a good substitute. See ZINC.

For other processes, see English patents: —

11,521, of 1847, Charles R. Lothman. Vapors produced in the process of brewing and air are introduced into the lead-chambers.

12,246, of 1848, Thomas Richardson. Finely divided metallic lead is treated with acetic acid, steam, and hot air, in trays lined with slate flags, at a temperature of 90° to 100° F.

12,724, of 1849, J. E. D. Rodgers. Lead is cast into sheets, which are doubled, and hung on frames. Troughs on the floor of the chamber are charged with malt, sugar, etc. Steam is admitted, through dilute acetic acid, in other troughs.

3,091, of 1857, Edwin Hills. Lead ore, roasted to drive off the sulphurous gases which are used for making sulphuric acid, is formed into stacks, and acetic-acid vapor introduced at their bases.

1,411, of 1858, Brown and Young. Carbonic-acid gas is passed through nitrate of lead, in solution. The carbonate thus formed is lixiviated with lime-water.

88, of 1860, George Robinson. Chloride of lead is mixed with carbonate of ammonia.

1,288, of 1860, William Baker. Uses salts of acetic acid instead of the acid itself.

642, of 1861, J. A. Phillips. The carbonic acid is expelled from lead ores by a dull red heat, and they are boiled in a strong solution of neutral acetate of lead; a current of carbonic-acid gas then causes a precipitate.

2,427, of 1865, Peter Spence. Ore prepared as above is treated with a carbonate, then with caustic soda, and, lastly, with carbonic-acid gas.

1,465, of 1867, William R. Lake. Chloride of sodium and oxide of lead are heated, forming oxychloride of lead; the pasty mass is treated with carbonic-acid gas.

1,278, of 1867, A. M. Clark. Metallic lead is moistened with the spray of acidulated water, and then treated with carbonic-acid gas, under pressure; the process is completed by treatment with chlorine and carbonic-acid gas.

*List of United States Patents for White-Lead.*

| No. | Name and Date. |
|---|---|
| —— | Holland, Mar. 18, '36. |
| —— | Clark,† ‡ Dec. 4, '28. |
| 95. | Richards, Dec. 2, '36 |
| 160. | Phillips, April 17, '37. |
| 264. | Ripley, July 11, '37. |
| 767. | Cumberland, June 7, '38. |
| 994. | Holland, Nov. 3, '38. |
| 1,115. | Button *et al.*, April 10, '39. |
| 1,231. | Clark, July 11, '39. |
| 1,424. | Clark, Dec. 5, '39. |
| 1,535. | Trovills, Mar. 31, '40. |
| 1,744. | Gardner, Aug. 28, '40. |
| 1,804. | Cory, Oct. 8, '40. |
| 3,232. | Gardner, Aug. 26, '43. |
| 8,292. | Pattison, Aug. 12, '51. |
| 12,616. | Baker, April 3, '55. |
| 13,657. | Rowland, Oct. 9, '55. |
| 13,931. | Schwabe, Dec. 18, '55. |
| 18,244. | Hannen, Sept. 22, '57. |
| 19,771. | Hannen, Mar. 30, '58. |
| 20,731. | Rowland, June 29, '58. |
| 22,036. | Smith, Nov. 9, '58. |
| 22,679. | Smith, Jan. 18, '59. |
| 23,815. | Albert, May 3, '59. |
| 25,106. | Erdmann, August 16, '59 |
| 29,665. | Brumlen, Aug. 21, '60. |
| 30,521. | Mayer, Oct. 23, '60. |
| 31,224. | Brumleu, Jan. 29, '61. |
| 33,337. | Cary, Sept. 24, '61. |
| 38,283. | Cobley, Apr. 28, '63. |
| 42,407. | Rowland, Apr. 19, '64. |
| 45,587. | Coggeshall *et al.*, Dec. 27, '64. |
| 46,706. | Archer *et al.*, March 7, '65. |
| 48,099. | Rowland, June 6, '65. |
| 48,243. | Baker, June 13, '65. |
| 51,018. | Chadwick, Nov. 21, '65. |
| 52,144. | Delafield, Jan. 23, '66. |
| 53,093. | Spence, March 6, '66. |
| 53,583. | Delafield, Apr. 3, '66. |
| 55,249. | Delafield, June 5, '66. |
| 56,685. | Fell *et al.*, J'ly 24, '66. |
| 59,135. | Overmann, Oct. 23, '66. |
| 59,901. | Fell* *et al.*, Nov. 20, '66. |
| 59,902. | Fell *et al.*, Nov. 20, '66. |
| 62,097. | Van Der Weyde,* Feb. 12, '67. |
| 62,130. | Hannen, Feb. 19, '67. |
| 64,763. | Hannen, May 14, '67. |
| 66,137. | Fell *et al.*, June 25, '67. |
| 66,138. | Fell *et al.*, June 25, '67. |
| 66,139. | Fell* *et al.*, June 25, '67. |
| 66,140. | Fell* *et al.*, June 25, '67. |
| 67,992. | Lewis, Aug. 20, '67. |
| 70,990. | Gattman,* Nov. 19, '67. |
| 77,818. | Jacobi, May 12, '68. |
| 80,168. | Hannen,† July 21, '68. |
| 83,357. | Bartlett, Oct. 27, '68. |
| 85,796. | Dale *et al.*,§ Jan. 12, '69. |
| 86,835. | Hannen,* Feb 9, '69. |
| 89,074. | Reakirt, Apr. 20, '69. |
| 91,267. | Repetti, June 15, '69. |
| 91,466. | Mayer, June 15, '69. |
| 92,816. | Gattman, July 20, '69. |
| 94,214. | Jacobi, Aug. 31, '69. |
| 95,075. | Bradley, Sept. 21, '69. |
| 95,097. | Dwelle, Sept. 21, '69. |
| 95,201. | Cuddy, Sept. 28, '69. |
| 97,365. | Dale *et al.*, Nov. 30, '69. |
| 97,936. | Lewis *et al.*, Dec. 14, '69. |
| 104,434. | Cuddy *et al.*, June 21, '70. |
| 105,431. | Cuddy, July 19, '70. |
| 108,433. | Bartlett, Oct. 18, '70. |
| 108,571. | Dwelle, Oct. 25, '70. |
| 109,125. | Hatfield, Nov. 8, '70. |
| 112,606. | Lewis, March 14, '71. |
| 112,607. | Lewis, March 14, '71. |
| 112,608. | Lewis, March 14, '71. |
| 113,014. | Brumlen, Mar. 28, '71. |
| 114,405. | Burridge, May 2, '71. |
| 116,604. | Lewis, July 4, '71. |
| 118,794. | Davison, Sept. 12, '71. |
| 120,556. | Wheeler, Oct. 31, '71. |
| 120,916. | Wadsworth, Nov. 14, '71. |
| 122,404. | Pollock, Jan. 3, '72. |
| 125,153. | Whiting, April 2, '72. |
| 127,395. | Wheeler, May 28, '72. |
| 136,446. | Meylert, Mar. 4, '73. |
| 137,474. | Osgood, April 1, '73. |
| 140,721. | Milner, July 8, '73. |
| 142,199. | Bœhne, Aug. 26, '73. |
| 142,419. | Tolle, Sept. 2, '73. |
| 145,713. | Armstrong, Dec. 23, '73. |
| 148,862. | Tuttle *et al.*, Mar. 24, '74. |
| 151,165. | Sevin, May 19, '74. |
| 151,497. | Meylert, June 2, '74. |
| 151,799. | Rueger, June 9, '74. |
| 154,643. | Brumlen, Sept. 1, '74. |
| 155,539. | Morse, Sept. 29, '74. |

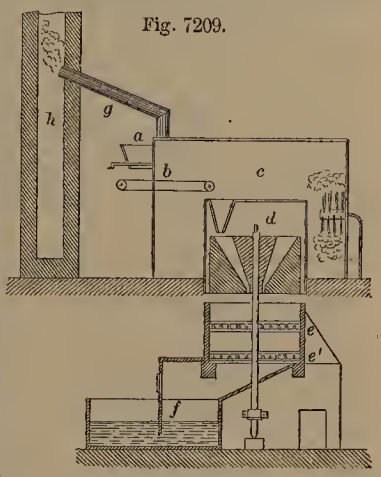
* Antedated.
† Reissued.
‡ Extended.
§ Patented in England.

See also ZINC-WHITE.

**White-lead Mill.** A mill for grinding white-lead, either in a dry or moist condition.

Fig. 7209 illustrates an apparatus invented by MM. Hameline and Besançon, in which the production of flying dust, injurious to the health of the workmen, is redueed to a minimum. The dried cakes of lead are placed in a hopper *a*, from whence they fall upon an endless band *b* withiu the chamber *c*, by which they are carried to the mill *d*, where they are pulverized. The powder falls upon a sieve, over whieh is a series of brushes conneeted to and revolving with the mill-spindle. The larger partieles are conveyed off through a channel *e*, while those which pass through the meshes fall on to a second sieve with brushes, the larger particles, as before, being discharged through a channel *e'* at the side, while the finer ones pass through and fall upon an incline, by which they are conducted into a vessel *f*, which may contain oil, or where they may be collected in the dry state. The chamber *c* has at its upper part a pipe *g* opening into the shaft *h*, which carries off such dust as is not eondensed by means of steam-jets *i* entering the chamber.

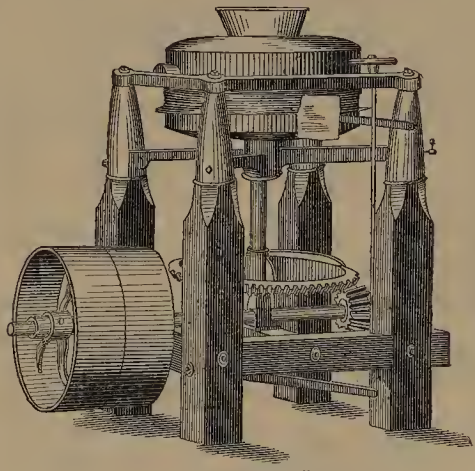
Fig. 7209.




*White-Lead Mill.*

Fig. 7210 illustrates a mill for grinding white-lead in oil or water. The pigment having been sufficiently moistened and mixed is fed through the hopper at the top, and is thoroughly comminuted and incorporated with the oil by the grinding action of two grooved disks, the upper one of which is rotated by gearing driven by belt and pulley and the lower one stationary. The spindle of the upper disk is stepped in a lever which is adjustable by a screw-rod and hand-wheel to vary the distance between the faces of the two disks, so as to regulate the fineness of the product.

Fig. 7210.



*White-Lead Mill.*

**White-leath'er.** Leather tanned with alum and salt, which does not discolor the hide or give it the brown appearance due to tanning by oak-bark or other ooze. See TAWING.

**White-line.** 1. (*Printing.*) A blank space between lines of types.

2. (*Nautical.*) An *untarred* cord or rope.

**White-mal'le-a-ble Al'loy.** See list under ALLOY. Specifically the list in 2d column, page 63.

**White-met'al.** A term usually applied to an alloy in which zinc, tin, nickel, or lead is in such quantity as to give it a white color, if white be a color, as it is for all reasonable purposes of description. See list, 2d column, page 63.

**Whit'en-ing.** (*Leather-manufacture.*) The process of cleaning hides at the beam, by passing a knife with a fine edge lightly over the flesh side, to bring it to the clean and fit condition for *waxing*.

**Whit'en-ing-ma-chine'.** A machine for removing the red skin or cuticle from the grain of rice after the outer husk has been hulled off.

The machine has a stone of coarse grit fixed on a spindle, like a grindstone, and revolving in a sheet-iron case, punched with holes like a grater, the protuberances of the apertures being inward. A space of about 1 inch intervenes between the stone and the case, and the latter has a door on the periphery, at which the rice is introduced. The stone is rotated by a band, at a rate of 250 revolutions per minute, and the case is allowed to rotate slowly. The rice is rubbed by the stone, the grains against each other, and against the asperities of the casing. The heat produced by friction swells the grain and bursts the cuticle, which is rubbed off, and escapes, in the form of red dust, through the holes in the casing.

Ewhank's rice-polishing or whitening machine (English patent, 1819) specifies a pair of concentric cylinders, the outer one fixed, and the revolving inner one covered with sheep-skin, with the wool outward. The rice is rubbed between the two, and the cuticle is thereby rubbed off and the grain polished.

Shiel's whitening-machine (English patent) consists of two wooden runners, covered with sheep-skin, with the woolen and the flesh sides of the skin exposed to the rice, which passes between the runners. The wool intervening between the leather and the wood gives a certain elasticity to the rubbing surfaces.

**Whit'en-ing-stone.** A fine-grained stone used by cutters.

**White Pat'terns.** (*Dyeing.*) In the India bandanna handkerchiefs the white spots are produced by covering them with sealing-wax and tying up tightly to protect them from the action of the dye. European manufacturers employ a *resist* or *discharge* for the same purpose, citric or tartaric acids being largely used for the latter object. The yellowish tinge which the white spots acquired during the subsequent washing was formerly provided against by mixing cow-dung with the water; the phosphates of lime and soda mixed are now, however, used to produce the same result.

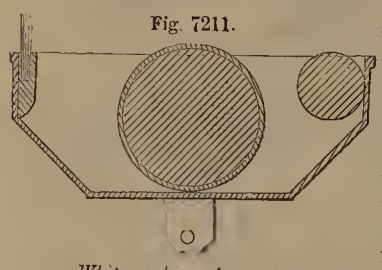
**White-rub'ber.** Caoutchouc mixed with such quantity of any white pigment as to give a dead white color to it. The ingredients are added in combination with sulphur, so as to make a white vulcanite when heat is applied. Oxide of tin, chalk, whiting, etc. See IVORY, ARTIFICIAL.

**White-stuff.** (*Gilding.*) A composition of size and whiting used by gilders to cover woodwork on which gold-leaf is to be laid. See GILDING.

**White Tom'bac.** A white alloy imitating silver. Copper, 14; zinc, 1. Arsenic to whiten. See MOCK-SILVER.

**White'wash.** A milk of lime used for painting walls. Its extreme whiteness is sometimes moderated by a little black or other color. An addition of size renders it more durable.

Fig. 7211.



*Whitewashing-Apparatus.*

**White-wash'-ing-ap'pa-ra'-tus.** A reservoir with roller and brush for whitening walls and ceilings.

The bibulous larger roller distributes the wash from the reservoir upon the ceiling; the smaller roller acts as a guide, and the brush precedes to remove dust.

**Whit'tle.** An old name for the clasp-knife.

"A Sheffield whittle." — CHAUCER.

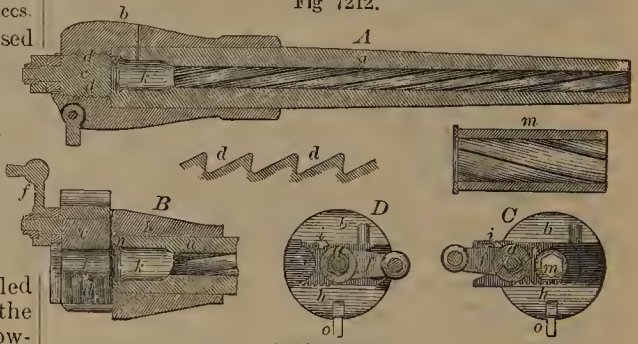
**Whit'worth Gun.** (*Ordnance.*) A kind of rifle invented by Mr. Whitworth of Manchester, England. The bore is hexagonal in section and has a very rapid twist. The projectiles are very elongated in form and adapted to closely fit the bore, studs and expansible rings being dispensed with. Cannon and small arms, both muzzle and breech-loading, are constructed on this principle, the breech-loading form, however, being generally adopted.

Fig. 7212 illustrates one of the latest of Mr. Whitworth's improvements. The gun is of cast-steel, compressed while still in a fluid state, whereby the tensile strength is greatly increased.

*A* is a vertical, *B* a horizontal section, *C D* end elevations showing the breech in open and closed positions respectively.

The barrel *a* is strengthened by a reinforce band *b*; in large guns more than one of these bands may be employed. The central part of the rear end of the reinforce is cut away, forming a groove in which the breech-block *c* slides. The faces of this opening have a series of parallel grooves *d*, adapted to receive a corresponding series of teeth *e e* on the breech-block, and by which it is held when pushed home in position for firing. These grooves are very slightly inclined to the axis of the bore, so that as the breech-block is moved into this position it is drawn up close to the face of the breech. The movement is effected by a lever *f*, connected by interlocking projections with a pinion *g*, which gears with a rack *h* at the bottom of the breech-opening; a pawl *i* dropping into a notch in the pinion *g* serves to hold it in place, but may be lifted to permit its removal. The cartridge-chamber *k* is of larger diameter than

Fig 7212.




*Whitworth Gun.*

the bore of the gun, and is somewhat enlarged at its base; to facilitate the insertion of the cartridge a groove *l* or a circular opening, corresponding in diameter to the cartridge, is also made in the breech-block; this opening receives a shot-guide *m* having an aperture through which the projectile is passed in loading, and by which it is directed into the bore; when in place this guide is removed and the cartridge inserted; to facilitate this the rear end of the bore is very slightly enlarged. By turning the lever *f* the breech-block is then slid into firing position and the gun is ready for discharge. The interlocking projections on the lever and the pinion *g* having a certain amount of play allow the lever to act as a hammer to more effectually start the breech-block at the commencement of this and of the return movement. A steel gas-check *n* is provided to prevent escape of gas at the breech. It will be observed that the grooves *d* are undercut to prevent any tendency on the threads of the breech-block to separate the two parts of the reinforce-band which serve as guides. *o* is the upper end of the elevating screw-link.

The nine-pounder field-gun on this plan is made from a solid ingot of steel, no reinforce-band being employed. Its length is 6 feet 2 inches; weight, 8¾ cwt.; external diameter at the breech, 10¼ inches; muzzle, 4½ inches; diameter of major axis of bore, 2.72 inches; of minor axis, 2.47 inches; charge of powder, 2¼ pounds.

The rifling has a twist of 1 in 55 calibers, and the ordinary projectiles are 3½ diameters in length, and are fired as cast, without being trimmed up. The carriage is also of steel, weighing 10 cwt.

Steel shot having their sides smoothly dressed up are frequently employed with the Whitworth gun, which is peculiarly adapted for firing solid shot, though hollow projectiles are also used.

Small arms rifled on this plan are better suited for hard metal than leaden projectiles; with the former great penetration and accuracy are attainable.

**Whole.** (*Mining.*) Where the coal has not been worked.

**Whole-and-Half Com'pass.** A proportional compass having two pairs of legs, one pair twice the length of the others, so that their respective reaches are as 2 to 1. A kind of *reducing* or *enlarging* compass. The Herculaneum cabinet shows a pair of

Fig. 7213.

*Whole-and-Half Compass.*

such, and the same may be seen in Ficoroni, "Gem. Liter.," tab. 6, 4to, 1757. Such are also seen in the Pompeiian collection. Also known as a *bisecting*-compass.

**Whorl'er.** A potter's whirling-table, on which he shapes circular articles.

**Wick.** A bundle of fibers to lead oil to the flame, where the oil is evolved as gas to maintain combustion. It acts by capillary attraction, and usually consists of a bundle of soft-spun cotton threads. Though the wick is usually charred, it is not a necessary condition. Some of the lighthouse lamps are made to overflow at the wick-tube, keeping so constant and profuse a supply that the wick is scarcely affected.

Small tubes of glass or bundles of wire have been used as wicks; asbestus was used by the ancients, and is yet used by the moderns. Gordon's English patent, many years since, described wicks composed of glass, metallic wire, or asbestus in fine filaments, formed into small bundles and bound spirally with wire or wrapped in wire-gauze. The liquid is conveyed by capillary attraction in the fine interstices between the parallel filaments to the flame.

Inventors have not entirely neglected the subject, as the following will indicate: —

Leslie, October 26, 1858. A wick composed of a single yarn, double-looped.

Wortendyke, April 26, 1859. A lamp-wick composed of strands that have received a preparatory twist in one direction are then spun in a contrary direction with and coiled upon a thread, and are then twisted together.

Weeden, January 1, 1861. A wick composed of a single strand in a series of single loops.

McKee, December 23, 1862. A lamp-wick made out of pulp, and felted or hardened together, instead of being woven, plaited, or twisted, and this whether the pulp be incased in an outer protection or not.

Connelly, January 6, 1863. The wick consists of an outside case or wrapper of linen, muslin, or other suitable substance, folded lengthwise over a filling of loose raw cotton, cotton-yarn, paper, pulp, or other substance possessing sufficient capillarity, the joint of the outside case or wrapper being secured by a narrow strip of thin muslin or other material pasted upon one side of the wick, where the edges of the wrapper meet.

White, August 28, 1863. A roving of unspun cotton, flax, jute, or other vegetable fiber, covered with a coating of gluten, by being passed through a vessel containing a solution of gluten, from whence it is passed to a tube to bring it to the proper shape, and afterward dried.

Larcher, July 7, 1863. At the upper end of a common wick is a section of asbestus, which is fed by the ordiuary wick, without waste of material.

Meucci, February 28, 1865. A lamp-wick made of paper pulp, and strengthened by means of bobbinet or other similar material.

Furlong and Long, April 4, 1865. The wick is saturated with a mixture of alum, graphite, and water, to render it nearly incombustible.

Noyes, December 19, 1865. The wick is made of closely woven fiber, inclosing loose longitudinal fibers to lead the oil.

Le Count and Chard, February 27, 1866. The wick is made of wool or woolen cloth.

Topliff, June 19, 1866. The lamp-wick is treated with alum and gum, to preserve it from combustion.

Le Count, October 30, 1866. Cotton threads run longitudinally through the wick, to increase its conducting power.

Hoard, November 20, 1866. The wick is made of paper pulp.

Martine, March 5, 1867. The wick has a core of wood, twine, or some firm substance that will consume with the wick; the addition gives stiffness to the wick, and enables the teeth of the elevating wheel to operate upon it more effectively.

Count Rumford invented the flat wick of soft cotton woven for the purpose, of the right width.

Argand of Geneva invented the tubular wick and the lamp named after him, which was the first lamp requiring a wick of that character.

The modification of the Argand, invented by Fresnel, for lighthouse purposes, has 4 concentric wicks, the outer one 3¼ inches in diameter.

L'Ange invented the lamp-chimney, adding it to the tubular wick and central air-tube of Argand.

The mosque of Cordova was lighted by oil-lamps and wax-candles, in the time of Al-Mansur. 75 pounds of cotton were consumed each month of Ramadhan. The number of brazen chandeliers was 280; the cups for oil, 7,425. The annual consumption of oil, 125 kintars (12,500 pounds). The wax-candles for Ramadhan, 300 pounds, with 75 pounds of cotton yarn for wick. The largest chandelier had 1,854 cups for lights. The four large ones were only lighted on special occasions, and burnt nightly 175 pounds of oil. — MAKKARI's (Arabic) *History of the Mohammedan Dynasties of Spain.*

**Wick'et.** 1. A gate, formed like a butterfly-valve, in the chute of a water-wheel, to graduate the amount of water passing to the wheel. It has a central spindle with a wing on each side.

2. A small gate for foot-passengers.

3. A half-high door.

**Wick-trim'mer.** A shears for trimming wicks. It has usually a shelf on one blade to hold the portion cut off.

**Wide-gage.** In England, the gage of the Great Western Railway, 7 feet.

Our broad-gage is such as the Erie. See RAILWAY-GAGE.

**Wig.** A false head of hair; the hair is fastened into a fabric or false scalp.

Some very fanciful and well-constructed wigs are found in the tombs of Egypt. The people, especially those of quality, were shaved regularly, except in time of mouruing. Several wigs have been preserved, and are now in the museums of London and Berlin.

The Egyptians wore false beards on the chin, the kind and style being determined by rank and condition.

Xenophon stated that the Persian monarchs wore wigs. It is probable that the splendid tresses and beards of the Assyrian monarchs and magnates, as seen in the sculptures of Nimroud, were artificial.

Tertullian cautioned his wig-wearing auditors to beware of wearing dead peoples' hair. Clemens of Alexandria declared that the episcopal blessing stayed in the wig and would not percolate through to the scalp.

The Greeks and Romans used false hair, and likewise hair-powder. Hannibal wore what may be called a wig; that of the Emperor Commodus was anointed with grease, powdered with gold-dust, and scented. The fashion was again set by St. Louis on his return bald-headed from the crusades. Henry III. of France had a skull-cap covered with false hair. In Louis XIV.'s reign wigs were fashionable. Hair was then woven into a linen cloth, and likewise into fringes, which were used under the name of *Milan points*. These fringes or laces were sewed in rows to plain caps, which were made of thin sheep-skin, and this head-dress was the French *peruque*, the Germau *parucke*, the English *periwig;* whence the term *wig*. One form consisted of three-thread tresses which were sewed to ribbons; these were then stretched out and sewed together on blocks cut into the shape of the head. Frizzing the wigs was introduced by one Ervais.

*Periwigs* first worn in England about 1590. Judges wore full-bottomed wigs 1674.

"I bought two periwigs, one whereof cost me £3 and the other 40 *s.*" — PEPYS, 1663.

The *peruke* was an Italian device, first worn at the French court, 1620; introduced into England, 1660.

Louis XIV., to hide his shoulders, which were not matches, introduced the long wig, and then no gentleman of quality at court could wear his own hair.

**Wig'an.** An open, canvas-like fabric, used as a stiffening in the lower ends of the legs of pantaloons, and as a skirt-protector on the lower inside surface which drags on the pavement. It is sometimes sold in strips, fluted, and attached to a band.

**Wig-block.** A shaped piece of wood for fitting a wig upon.

**Wig'ging.** See WIGAN.

**Wig'wag.** (*Watch-making.*) A rubbing-instrument used upon and driven by the lathe, being reciprocated longitudinally by crank attachment to some wheel of the lathe.

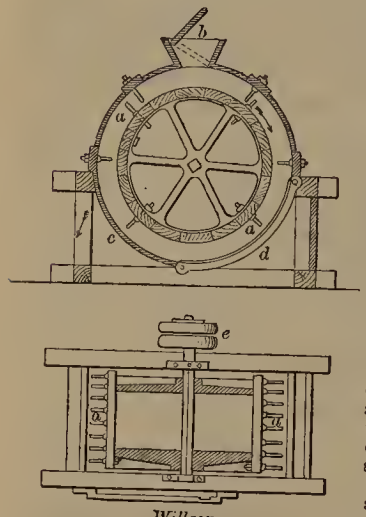
**Wil'low.** See WILLOWING-MACHINE.

**Wil'low-er.** See WILLOWING-MACHINE.

**Wil'low-ing-ma-chine'.** 1. (*Flax.*) A set of revolving bars for removing the pith and other refuse from flax, hemp, etc.

2. (*Cotton.*) A machine for cleaning cotton, similar to the *opening-machine*, and more particularly adapted for cotton of long fiber and full of impurities.

Fig. 7214.



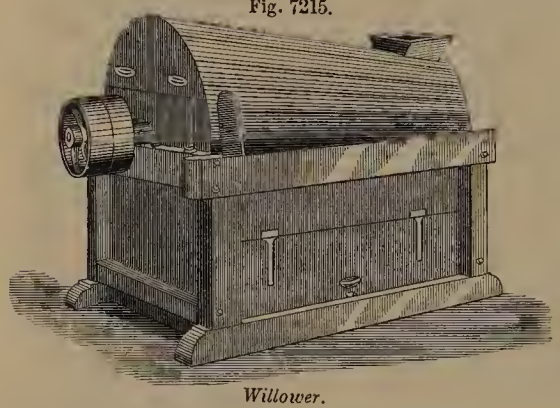

*Willow.*

The spikes *a a* are less numerous but much longer than those of the *opener*, the spikes of the drum passing between those in the cover.

The machine is fed through the hopper *b*, and the cotton is taken out through the door *c*, while the impurities pass through the grid *d*. The drum, which is driven by means of the fast and loose pulleys *e* at the rate of 300 revolutions per minute, can prepare 150-200 pounds of cotton per hour. Each charge consists of about 1¼ pounds, and the duration of each operation is about 25 seconds.

Fig. 7215 consists of a casing containing a conical beam studded with spikes, which pass between other spikes in the casing. The cotton is put in at one end of the machine, and being caught by the spikes, the flocks are pulled apart and the dirt shaken out while it is being gradually carried forward to the place of discharge. Sand and

Fig. 7215.



*Willower.*

heavier impurities fall through a grating at the bottom, while the dust and lighter matters are driven off by a fan and pass through wired openings into a chute. Called also *twilly*, *shake-willy*, *willow*, *wolly*, *willey*, *devil*, *opening-machine*. See also COTTON-CLEANING MACHINE.

The term *willow* is said to have been derived from the fact that in the early forms of the machine a cylindrical willow cage was used. It is more than probable that the term is derived from the willow-wands wherewith the cotton was beaten, to looseu it and eject the impurities, before the invention of machinery for the purpose. The finer varieties of cotton are yet *batted* with rods while resting on an elastic grated table; the felting-material for hats is similarly treated; and cow-hair to mix with plastering-mortar is also beaten with rods to separate and looseu the tussocks.

The willowing in the series of operations on ordinary cotton is followed by the batting-machine, in which *scutching*, *blowing*, and *lapping* are employed, to rid the cotton of remaining impurities, and bring it to a light downy condition, fit for presentation to the *carding-machine*, which lays the fibers parallel, in readiness for the operations of *drawing* and *twisting*.

3. (*Wool-manufacture.*) A large wooden cylinder having strong iron spikes about 3 feet long projecting from its periphery, and arranged in a spiral direction around it.

The cylinder is inclosed in a wooden case, and the wool is supplied to it by an endless apron and feeding rollers. The wool as it passes between the rollers is exposed to the action of the spiked cylinder, whose teeth tear apart the fibers of the wool, making it light and open, at the same time allowing dust and dirt to fall through a grating beneath. This is preliminary to the *picking* and *burring*. See WILLOWING-MACHINE; WILLOWER.

**Wil'low-peel'er.** A device or a machine for stripping the bark from willow wands.

A crotch with sharp edges is effective upon the wand which is drawn through it, the bark being loose upon the wood.

| Machines are also made for the purpose. | See patents Nos. |
|---|---|
| 62,629 | 21,740 |
| 58,747 | 40,252 |
| 84,324 | 34,201 |
| 29,535 | 70,288 |

**Wil'low-strip'per.** See WILLOW-PEELER.

**Wil'ly.** A machine having a spiked cylinder for tearing open the locks of wool before the *picking*, *burring*, *oiling*, and *carding* processes. A *devil*. See WILLOWING-MACHINE.

**Wil'son-snaf'fle.** (*Mancge.*) A jointed mouth-ring bit, the check-rings of which are loose and made in the usual manner; upon the mouth-piece there are two loose rings, into which the check-straps of the bridle are buckled.

**Wil'ton-car'pet.** A carpet made like Brussels, excepting that the wire is flattened instead of being round, and has a groove along the upper surface, which acts as a director for the knife by which the loops are cut and the wire liberated.

The Wilton-carpet is called *Moquette* by the French. By increasing the size of the wire, the carpet can be increased in

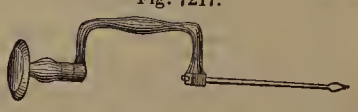
Fig. 7216.

*Pile-Fabric.*

thickness or quality. The quality of Wilton or Brussels is estimated by the number of wires to the inch. The usual number is 9 for Brussels, 10 for Wilton. After weaving, the nap is sheared. See BRUSSELS-CARPET.

**Wim'ble.** The old-fashioned name of the *gimlet*, then of the brace. A brace, used by marble-workers in drilling holes.

Fig. 7217.



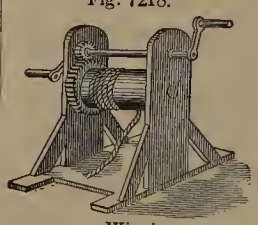
*Wimble.*

**Wince.** A form of washing-machine used by calico-printers and dyers. See WINCING-MACHINE.

**Win'cey.** (*Fabric.*) *Linsey-woolsey.*

**Winch.** The most simple form of hoisting-machine, consisting of a roller on which the rope is

Fig. 7218.



*Winch.*

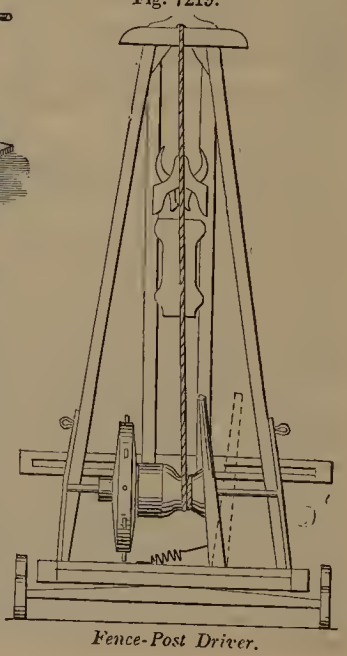
wound, the turning-power being a crank.

It has many modifications in respect of its adaptation to cranes and derricks. Increased power is obtained by placing a large spur-wheel on the roller-shaft and turning it by a pinion on the crank-shaft.

When on a movable frame, with drum and gearing, and adapted for hauling in the fall of the hoisting-tackle of *derricks*, etc., it is called a CRAB (which see).

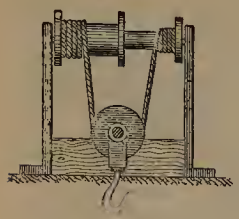
In Fig. 7219 the rope-

Fig. 7219.



*Fence-Post Driver.*

Fig. 7220.



*Chinese Windlass.*

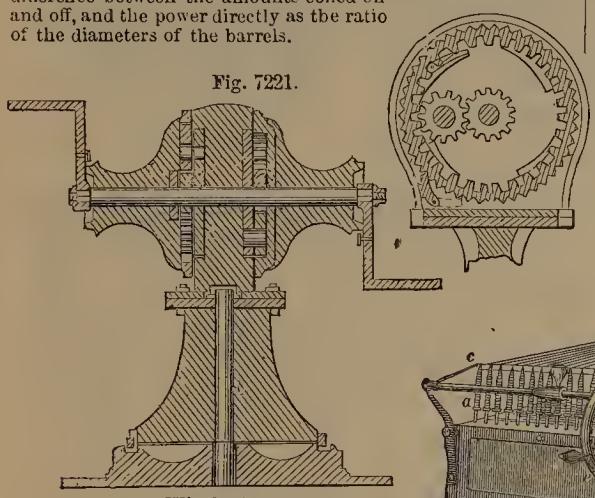
drum is turned by a spoke-wheel instead of by crank.

Fig. 7220 is a differential windlass.

In the differential windlass the rope winds upon the larger part of the barrel and unwinds from the smaller one, the elevation of the pulley being equal to half the difference between the amount coiled on and the amount payed off.

Dispense with the pulley, place the power on the rope of the larger barrel, and the load on that from the smaller barrel, and we have the ordinary *wheel and axle;* the elevation of the load being equal to the difference between the amounts coiled on and off, and the power directly as the ratio of the diameters of the barrels.

Fig. 7221.



*Winch-Capstan.*

**Winch-cap'stan.** A combination in which winch-heads are arranged on top of the capstan.

**Winc'ing-ma-chine'.** A wince is a reel (see WINCH) placed over the division-wall between two pits, so as to draw the cloth from either, discharging it into the other, according as the handle is turned.

It is used by dyers and calico printers in steeping or washing cloth. The *wincing-machine* is a succession of winces over which the cloth passes continuously over reels dipping into tanks placed in succession and holding a mordant, a dye, soap-suds, solution of bleaching-powder, a chemical solution of any kind, or water, as the case may be. The tanks are *wince-pots.* See WASHING-MACHINE, Figs. 7062, 7063.

**Wind'age.** (*Ordnance.*) The difference between the bore of the gun and the diameter of the shot fired therefrom. It varies from .15 inches to .9 inches for spherical projectiles.

Rifled guns are intended to avoid windage, various kinds of packing and sabots being used to fill up the space around the projectile.

**Wind-bar'row.** See WIND-CAR.

**Wind-beam.** Formerly, a cross-beam used in the principals of roofs, occupying the situation of the collar in modern king-post roofs.

**Wind-bore.** (*Mining.*) The pump at the bottom of a set of pumps.

**Wind-car.** One driven wholly or partially by the wind. The Chinese have sails on barrows, to be used when the wind is favorable. Wind-cars are also used on the plains of Tartary, if we may believe the poets.

Milton alludes to the wind-driven cars of the Chinese, as traversing the table-land of Asia: —

> "But in his way lights on the barren plains
> Of Sericana, where Chineses drive
> With sails and wind their cany wagons light."
>
> *Paradise Lost.*

We are not to infer that Satan saw the cars in motion, nor that Milton believed the modern theory, that mankind proceeded from several independent centers.

This would be granting the whole question, that the almond-eyed man of Cathay was scudding over the plains in pursuit of business or pleasure while Adam and Eve were yet disporting in Eden.

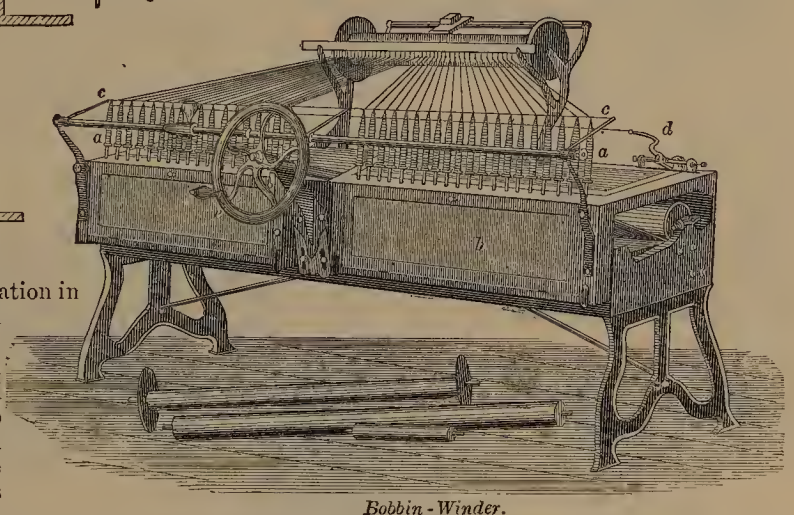
One form of the wind-car has sails like a windmill, which rotate an axle and impart motion to the driving-wheels. Such are described in old works on physics, published centuries ago.

The Chinese wind-wheelbarrow is drawn by a donkey, and when the wind is fair a sail is set. The wheel turns in the middle of a wooden frame, sustained by iron bars. Upon the frame are hung all kinds of utensils. The donkey is generally mounted by the paterfamilias, the son and heir walks behind, while the mother and younger ones ride on the vehicle. See also KITE, page 1230.

**Wind-chest.** (*Music.*) An air-tight box in an organ or other wind-instrument played by keys, into which the air is received from the *wind-trunk,* and from which air is admitted by valve-ways through the channels of the *sound-board,* to the air-ducts communicating with the respective pipes.

**Wind-cut'ter.** (*Music.*) In an organ-pipe, the lip or edge against which the issuing sheet of air impinges. The vibration thereby imparted is communicated to the column of air in the pipe, producing a musical note whose *pitch* is determined by the length of the pipe; the quality of the tone by the size of the pipe, and the material of which it is made.

Fig. 7222.




*Bobbin-Winder.*

**Wind'er.** (*Fiber.*) 1. A machine for winding yarn on spools. There are various forms for filling spools or bobbins from skeins, balls, cops, reels, or beams: the bobbin horizontal or inclined.

Fig. 7222 is a machine for winding from a beam on to upright bobbins *a* on skewers rotated by gearing within the box *b.* Two *falters c d* are used, one for building up the cop, the other for tension. In the figure the machine is shown as hand-driven by the wheel *e* in the rear.

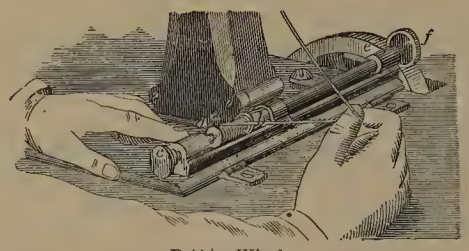
2. An apparatus for winding silk on to bobbins.

Each hank is extended upon a light, six-sided reel called a *swift,* a number of which are arranged side by side upon an axis on either side of the frame. The bobbins, one for each swift, are similarly arranged above, and the filaments being attached to the bobbins these are set in motion, causing the swifts to turn around and deliver the silk. The fibers pass through guides to which a traversing motion is imparted so that the silk is laid evenly on the bobbins.

3. A machine for winding bobbins for sewing-machine shuttles.

In Fig 7223 is shown the thread passing off from the spool of thread on the machine; *b* is the bobbin-winder; *a* is the bobbin in process of being wound; *c* is the head on the adjustable spindle-center that holds the bobbin, and is pulled out by this head in order to get the bobbin between it and the spindle;

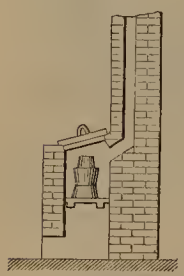
Fig. 7223.



*Bobbin-Winder.*

*d* is the point of the bobbin which should be oiled when it is being wound; *e* is the balance or fly wheel on the machine; and *f* is the bobbin-winder wheel.

Fig. 7224.



*Wind-Furnace.*

**Wind-fur'nace.** A furnace in which a strong heat is obtained without the use of bellows, by means of a powerful draft, dependent on a narrow flue or chimney of considerable elevation. Such furnaces are employed in chemical laboratories, and in smelting the more refractory metals.

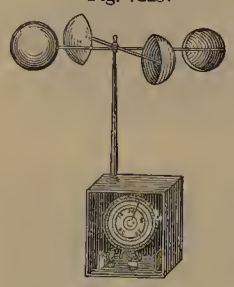
**Wind-gage.** An instrument for measuring the force or velocity of the wind. See ANEMOMETER.

Dr. Robinson's is now more generally used, perhaps, than any other.

It consists of four hemispherical cups attached to the ends of equal horizontal arms, which turn freely on a vertical axis. The axis carries an endless screw, which, by means of interposed gearing, rotates a hand or hands moving around one or several dials, or it is caused, by proper mechanism, to leave a record on an endless strip of paper.

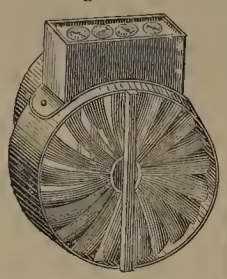
Williams's wind-gage, or air-meter, consists of a rotary vane *a*, surrounded by a cylindrical casing; the axis of the vane-wheel carries an endless screw, which, by suitable gearing,

Fig. 7225.



*Robinson's Wind-Gage.*

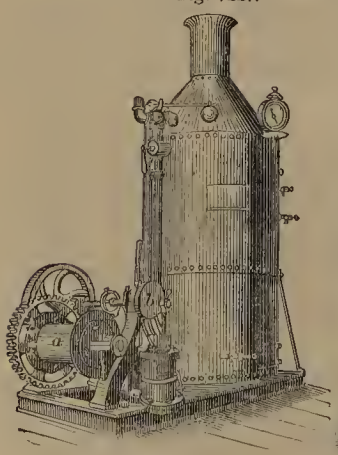
Fig. 7226.



*Anemometer.*

actuates the pointers on a series of dials; the gearing may be so adjusted as to cause the pointers to mark the number of revolutions of the wheel, the absolute velocity of the wind, or the quantity of air passing through the cylinder in a given time, in which latter case it becomes a meter.

Fig. 7227.



*Winding-Engine.*

In Professor Coffin's wind-gage each motion of the vane directed a minute but constant stream of dry sand into some one of 32 stationary hoppers, corresponding in position to as many points of the compass. The weight of sand found in the several receptacles below each hopper showed the length of time that the vane had pointed in that direction. In the observatory erected on the Greylock peak, 4,000 feet high, of Saddle Mountain, the instrument was arranged to run and register for three months in winter, when the peak was inaccessible. In this interval the clock-work faithfully did its entire duty The anemometer was changed by substituting for the stream of sand a series of cards half an inch square, laid consecutively on a moving band that deposited one of them every fifteen minutes. Each card being inscribed with the day and hour it represented, when the receptacle marked "North," for example, was examined, all the cards found in it indicated the exact quarter-hour in the past three months when the wind was from that direction. In 1872 a similar instrument was constructed for the observatory of the Argentine Confederation, at Cordova.

**Wind-hole.** (*Mining.*) A shaft or sump sunk to convey air.

**Wind'ing-en'gine.** (*Steam-engine.*) A hoisting steam-engine.

In the portable form (shown in Fig. 7227), the boiler and furnace are contained in an upright plate-iron case. The drum *a* on which the rope winds is rotated by a gear-wheel, into which meshes a pinion on a shaft carrying a disk *b*, having a wrist-pin, to which is attached the connecting-rod of the steam-cylinder *c*.

Fig. 7228 is an English winding-engine, adapted for small mines. The engine is of the usual size, with a Cornish boiler. The ore is raised by a double drum with a wire rope, one kibble being raised while another is lowered. A second shaft has a crank on its end for working the pumps by means of the balance-beam. The pumping and winding arrangements may be thrown in and out of gear, so that either may be worked singly.

**Wind'ing-gear.** An English term for the winding-machine for mines. The hoisting-engine is of the portable class. Each part of the rope passes over a separate pulley at top of the elevated stage, so that one kibble is being hoisted as the other descends (Fig. 7229).

**Wind'ing-ma-chine'.** A reel, swift, warping-machine, or similar contrivance. See BALLING-MACHINE; REEL; WINDER; etc.

Fig. 7230 is a machine designed to wind direct from the hank or skein to the shuttle-bobbin. It has 30 spindles, rotated by bands which reach from the spindle-whirls to the long drum *a*, which is common to the whole set. The skeins are laid around two spools *b c*, the lower of which is dependent and keeps the skein distended. The thread of the skeins passes upward to wire eyes *d d*, which are traversed back and forth over the bobbins so as to build up the thread symmetrically upon them.

See also WINCING-MACHINE; WASHING-MACHINE, for machines for winding fabrics through vats.

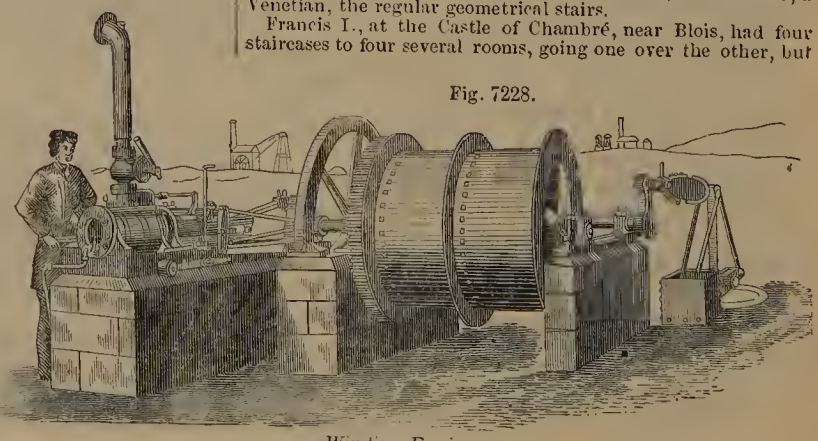
**Wind'ing-stairs.** Stairs ascending in a spiral line around a solid or open *newel*. See STAIRS.

Stairs are found at Persepolis. They were so gently inclined, and so wide, that horses might ascend them. The Roman stairs were usually narrow, steep, and inconvenient. The newel staircase in the Trajan Column has 3 parts for the newel and 4 for the stairs. The porticos of Pompeii had winding-stairs, with a well, so to call it, of columns, to give light to the staircase, which had no exterior window.

Triangular staircases are found in ancient buildings. Louis Cornaro invented winding-stairs without newel, and Barbaro, a Venetian, the regular geometrical stairs.

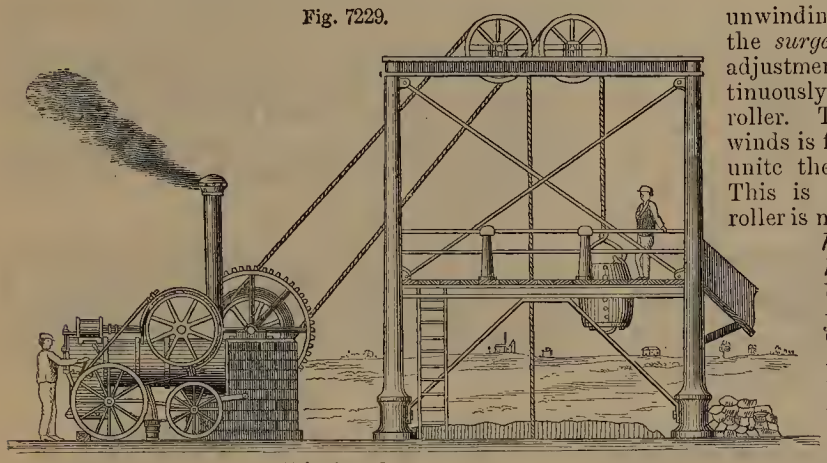
Francis I., at the Castle of Chambré, near Blois, had four staircases to four several rooms, going one over the other, but

Fig. 7228.



*Winding-Engine.*

Fig. 7229.



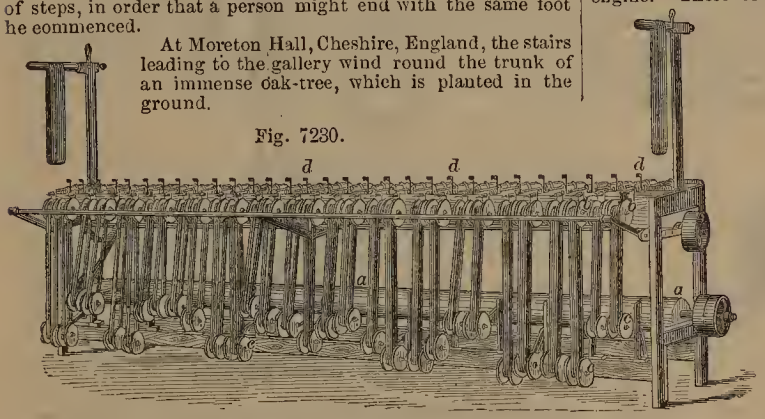
*Winding-Gear.*

so that persons to and from each traveled their own stairs, though in sight of each other. The northwest tower of Pontefract Church, England, has two circular flights of stairs, winding about the same center, with separate entrances below, and distinct landings above.

The ancient stairs had, to avoid omens, an uneven number of steps, in order that a person might end with the same foot he commenced.

At Moreton Hall, Cheshire, England, the stairs leading to the gallery wind round the trunk of an immense oak-tree, which is planted in the ground.

Fig. 7230.




*Shuttle Bobbin-Winder.*

**Wind'ing-tack'le.** A purchase of one fixed three-sheave block, and a movable double or treble block, suspended from a lower-mast head, and used in getting in or off heavy freight, stores, or armament.

**Wind-in'stru-ment.** A musical instrument in which wind is blown through a tube; in contradistinction to *stringed* and *percussion* (see list of each on pages 1500, 1501).

*Wind*-instruments are also divided into *with reeds* and *without reeds*; into *metal* and *wood*, *with* keys or *without* keys.

The organ is almost all-embracing, except that it has a key for each note. (See ORGAN.) See also MELODEON, ACCORDEON, and CONCERTINA, which are keyed, reed wind-instruments on similar principles.

Brass instruments with mouth-pieces are described and shown under HORN, Fig. 2564, page 1122 (which see).

Fig. 7231 shows wind-instruments of wood, with mouth-pieces and keys.

*a a'*, hassoons.
*b*, cors anglais.
*c*, oboe, or hautbois.
*d*, clarinet.
*e*, flute.
*f*, petite flute, octave flute, or piccolo.
*g*, musette.
*h*, flageolet.

The *octave* fife, or *piccolo*, is a wind-instrument of wood, without keys; the *syrinx* also.

**Wind'lass.** 1. (*Nautical.*) A large horizontal roller journaled in standards (*cheeks*, *windlass-bitts*), and rotated by handspikes or other means. It differs from the capstan principally in the horizontality of its axis. The hawser or chain-cable winds in a concave or slightly conical track, round which it makes two or three turns. As it winds up toward the larger end, it occasionally slips back without unwinding materially; this is called the *surge* of the cable, and this self-adjustment enables it to be wound continuously without accumulating on the roller. The surface on which the cable winds is formed of bars (*whelps*), which unite the *drum* with the *ratchet-head*. This is in cases where the windlass-roller is not solid, but consists of *ratchet-heads* (*a a*, Fig. 7232), *drum-heads* (*b b*), and *whelps* (*c c*), built around a *spindle* which is journaled in the *cheeks* (*d d*). The pawls are pivoted in the pawl-bitts *e e*, and sustain the strain while the handspikes are being shifted for a new purchase.

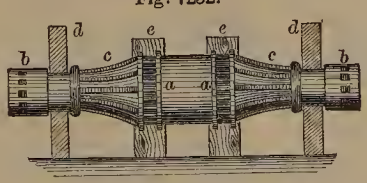
Smaller hoisting-machines, turned by cranks, are *winches*, and some are specially adapted to machines which revolve on their bases, as cranes, derricks, etc. See WINCH.

The old-fashioned mode of working a windlass was by spikes, which were placed like spokes in the holes of the drum, requiring that they should be shifted four times during each rotation. To avoid this, a pair of vertically oscillating levers have been attached to the bitt-head, forming *brakes*, like those of a fire-engine. These brakes — one projecting toward each end of the windlass — are connected by rods to pawl-boxes, which are sleeved upon the spindle, and act upon ratchet-heads on the windlass. By making a double system of pawls, that is, placing them on each side of the ratchet on the windlass, each stroke of the brakes may be made effective. The ordinary sustaining pawls pivoted to the *pawl-bitts* are retained, as usual, to prevent the back-lash of the windlass. The cable, or hawser, winds upon the *whelps*, and the *drum*, with its square sockets for the hand-spokes, may be used as accessory to the *brakes*. See Fig. 7233; see also CAPSTAN.

Fig. 7231.

*Wind-Instruments of Wood.*

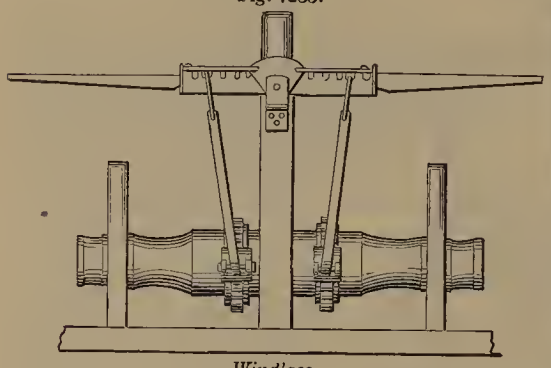
Fig. 7232.




*Windlass.*

In another form of windlass (Fig. 7234), the ratchet-heads are dispensed with, *purchase-wheels a a* having plain surfaces being employed; these are acted on by *nipping-levers c c*, con-

Fig. 7233.



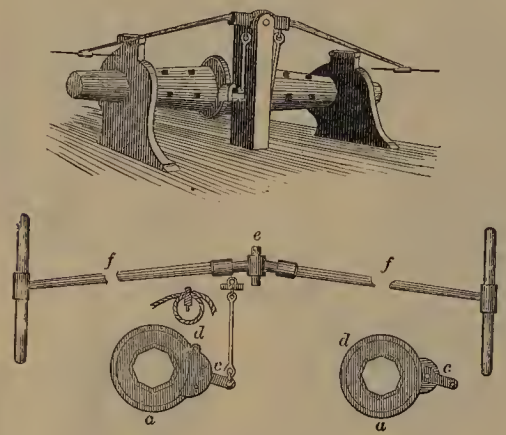
*Windlass.*

fined to the purchase-wheels by iron rings *d d*, called *travelers*, which in descending move freely round. The nipping-levers are connected by links to the brake-levers, and by biting alternately upon the purchase-wheels heave the windlass round as they ascend; the cross-head *e* of the sway-beam has sockets to receive the brake-levers *f f*, which are bent so as to clear the knees of the bitt-heads.

The windlass still used in the Chinese seas, even for large junks, consists of a roller extending across the vessel from side to side, and turned by spikes, which prevent the unwinding by resting on the deck.

In 1776, when Falconer, the author of the "Shipwreck," wrote his "Marine Dictionary," the windlass in English ships had its gudgeons in windlass-bitts, and was furnished with pawls of wood or iron which fell into notches in the periphery of the windlass. These notches, being eight in number, sus-

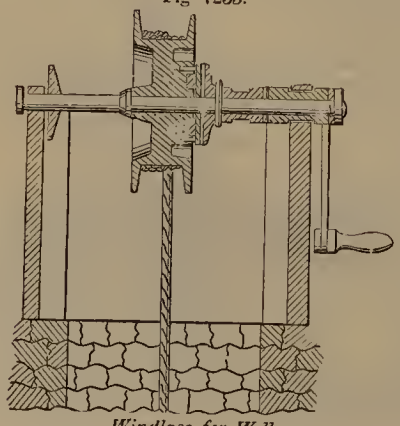
Fig. 7234.




*Windlass.*

tained the strain on the cable at every seven inches hauled in. Afterwards the "pawl and half-pawl" arrangement was introduced, which sustained the cable at every 3½ inches. William Falconer was the son of a barber, born at Edinburgh, 1730; he published the "Shipwreck," 1762. He was appointed purser of "Aurora" frigate, which sailed from England, September 30, 1769, and after touching at Cape of Good Hope was never

Fig 7235.



*Windlass for Wells.*

heard from. Supposed to have foundered in the Mozambique Channel.

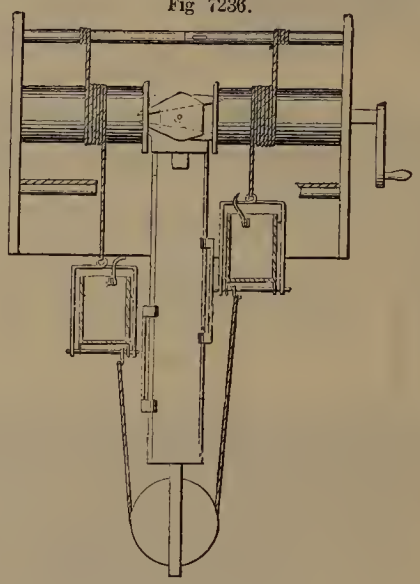
The windlass is more powerful than the capstan, in proportion to the men employed, as a man can exert a power of about 150 pounds on a windlass-handspike, but about 35 pounds on a capstan-bar. A greater number of men, however, can reach the capstan.

A combination of the capstan and windlass is shown in Coffin's patent, No. 59,969, November 27, 1866. See also Fig. 1085, page 457.

2. A well-bucket elevator.

In the form shown in Fig. 7235, the loose drum has a friction-disk which is backed by springs and engages a similar disk on the crown-ratchet sleeve, having longitudinal movement on the winch-shaft. This ratchet engages a similar ratchet of the shaft to remove the collar and engage the disks. The shaft has a spur-ratchet and drop-pawl to prevent back rotation. The disks acts as brakes in lowering the bucket.

Fig 7236.



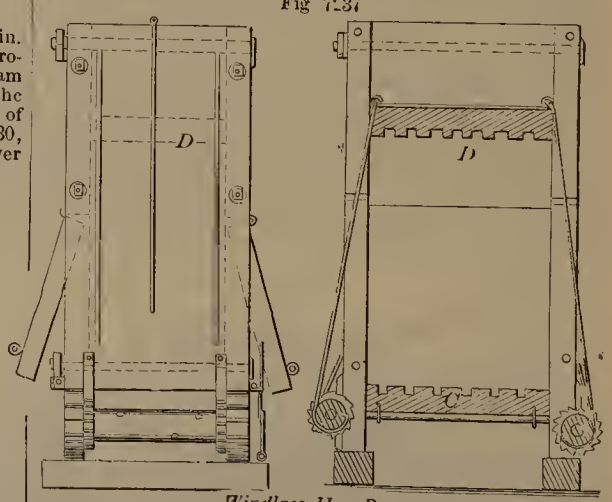
*Well-Bucket Windlass.*

In Fig. 7236, the buckets are alternately raised and lowered by the continued revolution of the winch in one direction.

3. The differential windlass is shown in Carpenter's "Mechanical Philosophy," London, 1844, page 282.

It is therein credited to Mr. Moore of Bristol. The hand portion of the continuous rope passes over the larger wheel,

Fig 7237




*Windlass Hay-Press.*

and the weight portion over the smaller wheel, the value in hoisting power being equal to the difference in the radii of the two wheels. It is the same principle as shown in the Chinese windlass, Fig. 1651, page 701, but is a very neat application of the idea. See also Fig. 7220.

**Wind'lass Bal'ing-press.** One in which the power is brought to bear upon the platen or follower by means of rope and windlass.

In Fig.7237, the pressure is brought to bear upon the bale by the descent of the follower *D* toward the bed *C*. In discharging the bale, the bottom is hinged at one side and supported on adjustable blocks, so that it may be allowed to fall slightly, taking its pressure from the doors when the holding-bars of the latter are being removed. The sides of the press are sprung out by toggle-levers, to loosen the bale for removal.

Fig 7238.

*Tripod Windlass Screw-Jack.*

**Wind'lass-jack.** A form of lifting-jack having a winch-handle for turning the pinion which gears into the crown-wheel. See also SCREW-JACK.

**Wind'mill.** A mill in which motion is imparted to mechanism, for grinding grain or for other purposes, by the action of the wind on a series of revolving sails. Commonly met with in flat districts of country or in other situations where water-power is not available.

Pomponius Sabinus states that hand-mills were brought to Rome from Greece, and that one Paulo also introduced windmills for grinding grain. This was a little before the time of Augustus. In the "Spiritalia" of Hero of Alexandria, 150 B. C., we find the description of an organ blown by the agency of a windmill which worked the piston of an air-pump. See ORGAN.

Beckmann, in his "History of Inventions," denies that the Romans had windmills during the period of the Empire. They were not uncommon in Europe at the time of the Crusades. The earlier Roman mills, after the hand-mills, were driven by water either from the aqueducts or by the current of the Tiber. See WATER-WHEEL; CURRENT-WHEEL; MILL; ETC

They are mentioned in England A. D. 1180, and from the twelfth to the fourteenth centuries notices of them are common.

Mabillon mentions a charter of 1105, A. D., in which a convent in France is allowed to build water and wind mills, *molendina ad ventum*.

Bartolomeo Verdè had a grant of land to build windmills in Venice in 1332. They were in use at Spires in 1373, and at Frankfort in 1442.

In the twelfth century, the Pope decided that the usufructs of water and wind mills were tithable.

It took some time to determine the legal bearings of this question. In the fourteenth century, the prior of the monastery of Augustines, at Windsheim, in the province of Overyssel, was desirous of erecting a windmill. When the lord of Woerst heard of this he forbade it, on the ground that "the wind of Zealand" belonged to him. Appeal was taken to the Bishop of Utrecht, who flew into a towering passion, and declared that no one had power over the wind within his diocese but himself and the Church at Utrecht. He granted letters-patent, and the mill was erected.

It is stated that the first mode adopted to present the vanes towards the wind was to float the mill and turn it in the water, as occasion required.

The next was to put it on a post, and turn the building on this, as an axis. This was called the German method.

The next was to turn the cap, or roof. This was a Dutch invention, in the sixteenth century. See WINDMILL-CAP.

The principal parts of the common windmill consist of an axle, inclined to the horizon at an angle of 8° to 15°, and carrying at its outer end four sail-frames, or *whips*, usually about 40 feet long, consisting of a long tapering bar of wood, with short cross-pieces, whose extremities are connected to each other by a wooden strip. Upon these frames the canvas sails are spread. Reefing arrangements are sometimes provided to diminish the area of the sails during high winds. The whole frame of the mill turns upon a vertical shaft, and, by means of a lever, may be adjusted to cause the sails to present their surfaces directly to the wind.

The inclination of the axis is for the same purpose, it being found by experience that the direction of the wind is somewhat downward, generally forming, in open countries, an angle of about 18° with the surface of the ground The sails are also advantageously arranged, so as to have a somewhat winding surface, the lower part forming an angle of about 60°, and the upper of about 80°, with the axis, the concavity facing the wind. The breadth of the sails is usually about $^1/_5$ or $^1/_6$ of the length, which varies from 30 to 40 feet, and they are preferably widened toward their outer extremities. Their maximum effect is attained when their outer ends revolve with about 2½ times the velocity of the wind.

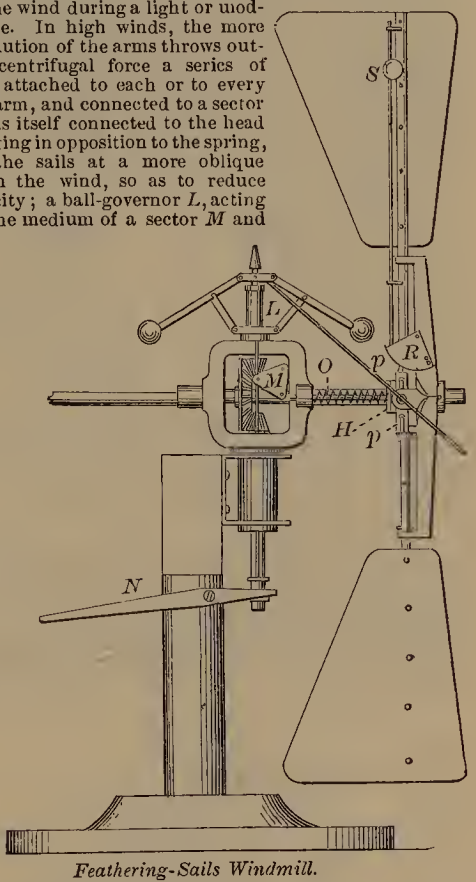
In 1772 Andrew Meikle, of Scotland, invented a plan for automatically adjusting the area of the sails to the force of the wind; and in 1804, Bywater of Nottingham, England, patented a method of rolling up the sails to adjust them in like manner, by means of a weighted lever, which was caused to operate gears, connected by cords to cylinders, on which the sails were wound.

More recent devices of this kind generally aim to effect this adjustment by altering the angle at which the sails are presented to the wind.

In some cases the axis on which the sails rotate is caused to fall in the line of direction of the wind by means of a vane of considerable area attached to the movable framework of the mill.

In Fig. 7239, the sails *D* turn on rods having cranked ends *p* inserted into holes in the sliding-head *H*, which is pushed outward by means of a spring *O* of sufficient tension to present the sails at a proper angle to the wind during a light or moderate breeze. In high winds, the more rapid revolution of the arms throws outward by centrifugal force a series of weights *S* attached to each or to every alternate arm, and connected to a sector *R*, which is itself connected to the head *H*, and, acting in opposition to the spring, presents the sails at a more oblique angle with the wind, so as to reduce their velocity; a ball-governor *L*, acting through the medium of a sector *M* and

Fig. 7239.




*Feathering-Sails Windmill.*

connecting-rods, is also provided for the same purpose. A lever *N* permits this adjustment to be made by hand.

Horizontal windmills, though exerting much less useful effect, may be used where the hight of the vertical sails is objectionable. The usual form consists of a wheel or fly having six sail-beams, near the ends of which are pivoted vanes, which are divided by lines passing through the pivots into two unequal portions. As these revolve, the wind, first acting against the broader side, lays the vane flat against the arm, where it is held by a stop and exposed to the full power of the wind; on proceeding farther, it is taken aback and swings around so as to feather, or present its edge to the wind until it again comes into its former position.

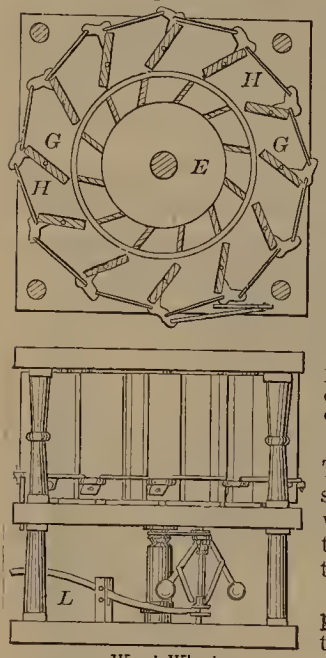
Another plan is to form each sail of pivoted slats, like those of a Venetian blind, so arranged as to open and permit the free passage of the wind as the sail comes up to the wind, but close so as to receive the full effect of the wind when moving in the opposite direction.

Fig 7240 is a horizontal windmill in which an exterior series of shutters *G G* connected by rods *H H* are automatically adjusted to admit more or less air to the interior wheel *E* by means of a ball-governor driven by connection with the wheel and operating a lever *L*.

The ball-governor was first used in windmills, and James Watt borrowed the idea from thence.

In Holland, windmills are employed in driving the scoop-wheels which drain the polders. The mill resembles exteriorly an ordinary windmill, but the upright shaft is carried down to the bottom floor, where a bevel wheel is placed upon it, and another on the shaft of the scoop-wheel to which it communicates the motion. The scoop-wheel has flat blades, arranged to work in a chase which they fit accurately. The wheel in its

Fig. 7240.




*Wind-Wheel.*

revolutions lifts the water from the lower to the higher level. These wheels are not economically effective in lifting to a hight above the center of the axle. See SCOOP-WHEEL.

Holland is said to have 12,000 windmills in operation, averaging eight horse-power each. The annual cost is reputed at $4,000,000. When very heavy and continous work, however, is required, steam is the more reliable. It has superseded to a large extent the windmills of the fens and low counties of Eastern England. See also DRAINING-ENGINE, for account of the Haarlem lake-engines in Holland.

**Wind'mill-cap.** The movable upper story of the wind-wheel which turns to present the sails in the direction of the wind.

**Wind'mill-propel'ler.** An application of a wind-wheel to the propulsion of a boat.

**Win'dow.** From the Welch *wyntdor*, wind-door. Originally an opening for ventilation; afterwards an aperture for light, protected by mica, oiled linen, horn, paper, or glass. These articles were probably introduced in the order stated.

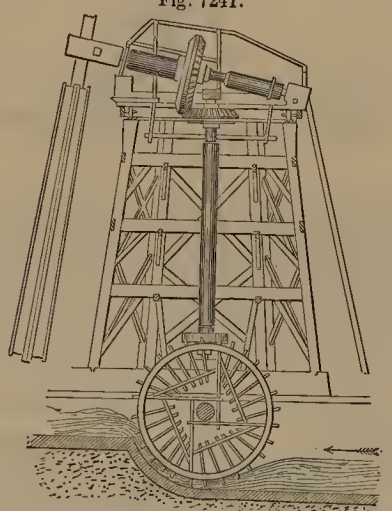
"A window in the ark."

"A place in Cappadocia produced large masses of transparent stones for windows, which were exported." — STRABO.

Pliny mentions horn windows for lanterns, and Tertullian *corneum specula*, horn windows for houses.

Transparent windows were a curiosity in the time of Seneca Stone and glass windows were introduced into England by Wulfrid, Bishop of Worcester, in 736; or by Benedict Biscopius.

Fig. 7241.



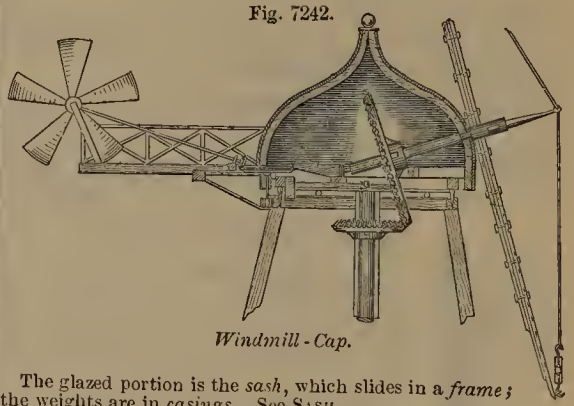
*Dutch Draining-Windmill and Scoop-Wheel.*

*Trefoil* openings within triangles are of the time of Edward I. In the reign of Richard II. they were subdivided by upright *mullions*, dividing the window into *lights*. The molding grew more graceful and light in succeeding centuries. It was long before the cloisters were closed with windows, and then not entirely, for spaces were left for access of fresh air.

Windows to the floor are the *valvatæ fenestræ* of Vitruvius.

"The windows of Manila, in the Philippine Islands, have sliding frames fitted with *concha* or plates of semi-transparent oysters, which admit an imperfect light, but are impervious to the sunbeams. I do not recollect to have seen any glass windows in the Philippine." — BOWRING.

Fig. 7242.



*Windmill-Cap.*

The glazed portion is the *sash*, which slides in a *frame*; the weights are in *casings*. See SASH.

The piece above a window is a *lintel*, below it a *sill*; the sides of the openings are *jambs*; the exposure of the sides between the face of the wall and the sash-frame is the *reveal*.

Windows are of various kinds, — Gothic, mullion, casement. Bay-windows were invented about the fifteenth century.

*Double window*; having inner and outer sash, with a body of air between.

*Double-hung window*; having two sashes, each with its complement of lines, weights, and pulleys.

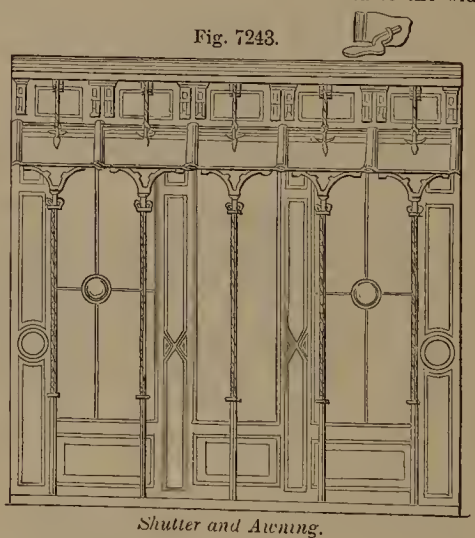
**Win'dow-blind.** A curtain shade or shutter to close the window against light, or to make it safe against intrusion.

In Fig. 7243, the metallic blind is hinged at top, and is drawn upward by cords to form an awning. Rods hinged to its outer edge are let down to form supports.

Fig. 7244 shows a roller blind made of slats and adapted to close any portion of the window, either above or below the meeting rails of the sashes.

The flexible blind is wound on a roller upon whose journals are wound the side tapes which are connected to the window-

Fig. 7243.



*Shutter and Awning.*

frame above. One cord supports in its loop and adjusts the hight of the lower roll of the blind; the other cord winds with the upper roll and adjusts its hight by winding it or allowing it to unwind its contents.

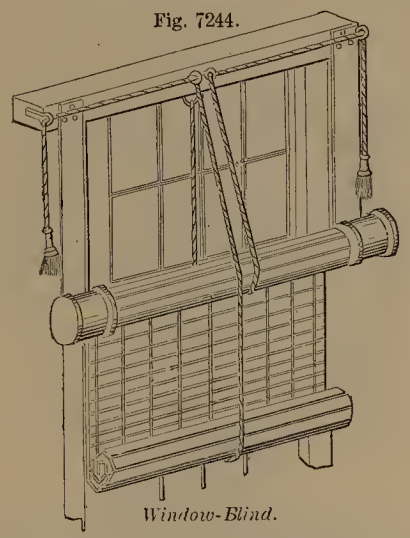
**Win'dow-glass.** Common window-glass is made into circular disks by the familiar blowing and whirling processes.

The pontil of the glass-blower is dipped into the glass-pot and abstracts therefrom a mass of glass, which is blown into a globular shape. The end being pierced, and the bulb whirled, the opening enlarges until, by centrifugal action, the plastic mass assumes a flat shape. This is the method generally employed in England. The best variety of this is *crown-glass*.

Other window-glass is made in what is called *cylinder* or *sheet glass*. The mass of glass is blown into a cylindrical form, the end cut off, the cylinder split longitudinally and flattened. This is the usual German and Continental process. The glass of the London Exposition building of 1851 was made in this way. See CYLINDER-GLASS.

The best kind of window-glass is that called *plate-glass*. This is poured in a molten condition upon a table, and a heavy roller passed over the fluid mass. The plates are after-

Fig. 7244.



*Window-Blind.*

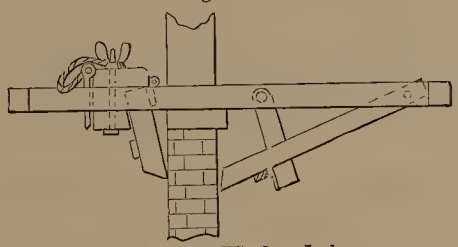
ward ground smooth and polished. See CROWN-GLASS; CYLINDER-GLASS; PLATE-GLASS; and specific index GLASS.

Though known to the Egyptians at a very remote period, glass appears to have been little used for illuminating purposes by the ancients.

Rome had but few glazed windows in the reign of Nero. Its use seems to have gradually become more general during the dark ages, principally, however, in ecclesiastical edifices.

Glass windows were placed in the monastery of Weremouth, A. D. 647. St. Jerome, who wrote early in the fifth century, and Gregory of Tours, who wrote in the sixth century, mention glass windows. The use, however, was not general in the

Fig. 7245.



*Painter's Window-Jack.*

twelfth century. Henry III. had glass windows in his palace of Woodstock, 1265, and at Westminster. Chaucer mentions them. Scattering mention is made of them in succeeding ages, and they became common in farm-houses about 1600.

The Venetians led the way among European nations, and attained great excellence, both in quality and taste of design; their ware was regarded with admiration, and has been preserved in England among other articles of vertu.

A factory was established in England in 1557, and improved in 1635, about which time pit coal was substituted for wood. In 1670, Venetian artists were introduced into England, and established the art in that country.

Casting glass was invented by Theraut, a Frenchman, in 1688, and was introduced in England, at Prescott, in 1773.

The art of coloring glass was well understood in ancient Egypt, as we observed in reference to the imitation of glass.

Stained glass was originally a mosaic, made up of different pieces, arranged, according to color, to form a design. About 1500, a French artist at Marscilles incorporated colors with the glass, which were baked in. Albert Durer practiced the art.

WINDOW-GLASS.

*Thickness and Weight per Square Foot.*

| No. | Thickness. *Inch* | Weight *Oz.* | No. | Thickness. *Inch.* | Weight. *Oz.* |
|---|---|---|---|---|---|
| 12 | .059 | 12 | 21 | .1 | 21 |
| 13 | .063 | 13 | 24 | .111 | 24 |
| 15 | .071 | 15 | 26 | .125 | 26 |
| 16 | .077 | 16 | 32 | .154 | 32 |
| 17 | .083 | 17 | 36 | .167 | 36 |
| 19 | .091 | 19 | 42 | .2 | 42 |

**Win'dow-jack.** A scaffold for carpenters, painters, or cleaners, enabling them to reach the outside of the window.

The frame has pivoted brace-bars to rest against the outside of the house, and hold-fasts hinged to an adjustable block; these rest against the inside of the window-frame.

**Win'dow-lock.** A fastening for the meeting rails of sashes.

**Win'dow-sash.** The frame holding the lights or panes of glass. The sash is held by counterpoise weights and cords running over pulleys in the jambs of the sash-frame, or may be held by spring latches, such as Hammond's, for instance, which enter notches in the edges of the sash.

Fig. 7246.

*Window-Shade.*

**Win'dow-shade.** A blind for windows, usually rolling.

Legg's window-shade (Fig. 7246) is arranged to admit light either from the top or bottom of the window. The curtain is wound upon a roller suspended by webs from spiral springs contained in boxes above. As shown, the roller is drawn down and the curtain hooked below; when released, the roller is raised by the springs, and the curtain may be hoisted in the usual manner by the cord.

Fig. 7247.

*Window-Tube.*

**Win'dow-tube.** (*Telegraphy.*) An insulating device for introducing line wires into telegraph-offices. It consists of a glass or hard rubber tube of any required length, and having a head at one end which is placed inside the building. The iron wire is fastened to an insulator outside and projects through the tube into the office, for ¼ to ½ an inch. A screw-thread is cut on its end, which receives a main line binding-post, and from this the copper office wire is run to any part of the room.

**Wind-pump.** A pump driven by a wind-wheel.

**Wind-sail.** A canvas tube is used as a wind-conductor, having its open mouth presented towards the wind, or in the direction of motion, as on board a steamship, where it is used to direct a current of air down into the engine-room to moderate the intense heat and improve the draft of the fires.

The wind-sail is used quite commonly on ships to ventilate and cool the cabins and "tween decks," especially on board vessels in tropical climates, and on board those floating coffins, — *monitors.*

**Wind-trunk.** (*Music.*) The air-duct which conducts air from the bellows to the wind-chest of an organ or similar instrument.

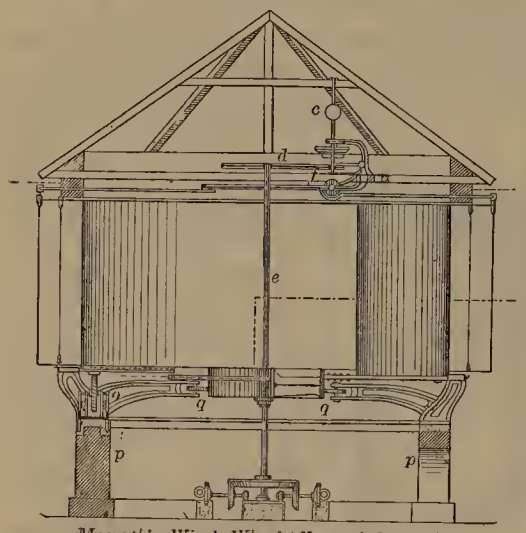
**Wind-way.** (*Mining.*) A passage for air.

**Wind-wheel.** A wheel acted upon by the wind and used to communicate power. Among its familiar applications are the windmill, wind-pump, and anemometer. See WINDMILL.

Moerath's wind-wheel, on exhibition at the Paris Exposition of 1867, is of the horizontal class. The air is directed against the curved wings *a a* by guides *b b*, Fig. 7248, and is discharged at the center of the wheel. When the arms have reached a point where the direction of the wind is tangential, the overlapping ends of the guides cut it off and prevent its exercising a retarding action.

To regulate the amount of air admitted to the wheel in proportion to the velocity of the wind, the governor *c* is provided. When the velocity of the wheel is in excess, the gear-wheel *d* on the shaft *e* of the wind-wheel, gearing into the pinion *f* on the governor-shaft, imparts a more rapid rotation to the latter, opening out the governor-balls and raising the doubly conical wheel *g* into contact with the bevel wheels *h h'*; the first of these, through the bevel wheels *i i*, the former on the shaft *j*, passing through the hub of the wheel *k*, acts on the screw *l*, which meshes with a worm-wheel *m* connected by a series of rods *m' m'*, pivoted at each end with the hinged shutters *n n*, and turning wheel *m* from right to left, operates to close the shutters and diminish the area through which the wind can enter, until the speed of the wind-wheel is reduced to the proper running velocity. The wheels *k' k* are idlers, serving merely as bearers for the conical wheel *g*. If the wind lull so that the wind-wheel does not rotate with sufficient velocity, the falling of the governor-balls causes the wheel *g* to come in con-

Fig. 7248.

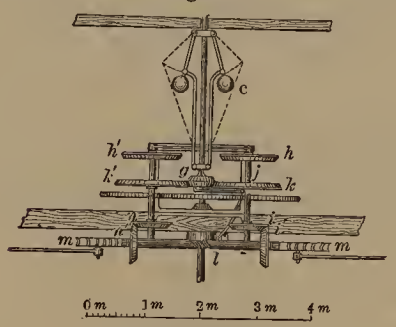


*Moerath's Wind-Wheel (Vertical Section).*
*(Paris Exposition, 1867).*

tact with the wheels *k k'*, and the latter through the bevel-gears *n n'* and screw *l* moves the worm-wheel *m* in the reverse direction, widening the distance between the shutters and permitting more air to pass.

The wind-wheel is borne upon rollers *o o*, running on a circular track at top of the foundation *p p*; other rollers *q q* bear-

Fig. 7249.



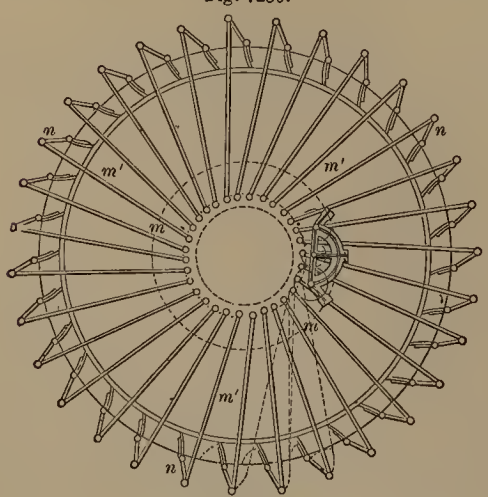

*Wind-Wheel (Section).*

ing against the circular shell of the air-discharge space prevent tendency to lateral displacement.

**Wine-age'ing Ap'pa-ra'tus.** A device for treating liquor, to give it, by a speedy process, the same character as is conferred by age.

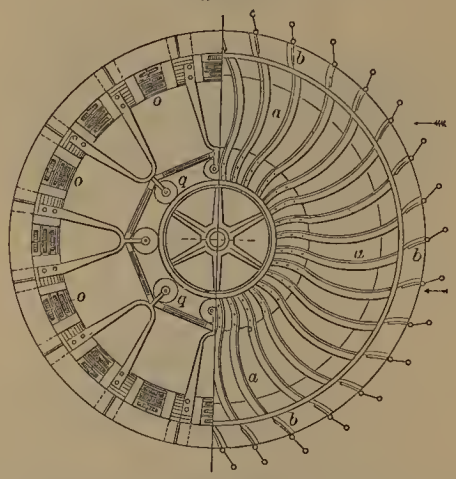
Fig. 7252 is an apparatus for this purpose, in which the liquor is subjected to heat and agitation in a close vessel, the rising

Fig. 7250.



*Wind-Wheel (Plan).*

Fig. 7251.



*Wind-Wheel (Partial Section and Plan).*

vapors being condensed and removed. The heat is derived from steam and hot water, and is gradually applied.

Martin, May 21, 1867, uses the combined action of heat, electricity, and attrition for the same purpose.

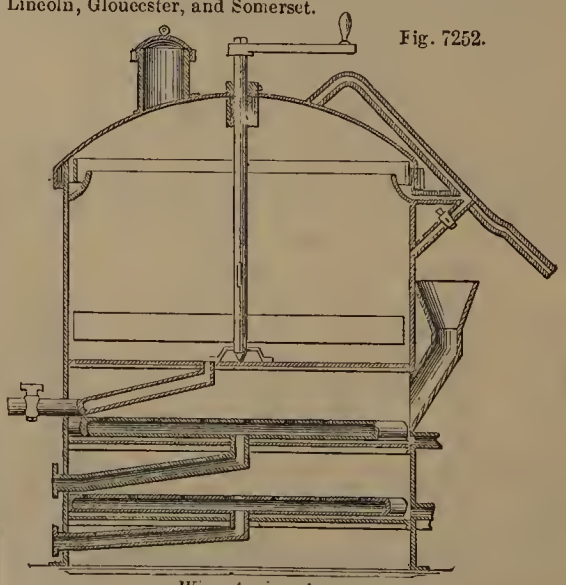
**Wine-cool'er.** A tub or bath in which bottles of wine are surrounded by ice to render the contents more palatable in warm weather.

**Wine-press.** Hardly any race of people, however uncivilized, has been discovered which was not possessed of the secret of procuring intoxicating drink of some kind, either the produce of animals, as honey (*metheglin*); mare's milk, fermented by the Tartars, forming the liquor known as *koumiss*, and possessing intoxicating properties; from the ceralia (beer, whisky, arrack), the juice of fruits (wine, grape, apple, and peach brandy), or the sap of trees and plants, namely, maple sap, plaintain, and agave wine.

Little is positively known of the ancient wines except from Pliny, who says that the vine was first cultivated at Rome about 600 B. C., and that the Greeks and Romans had a method of concentrating the wines, either by spontaneous evaporation or boiling, and of reducing them to a sirup or even to a solid cake, in which state they were preserved for many years. Wine two hundred years of age is mentioned by Pliny, its age being considered, as now, a criterion of goodness.

In the time of the Roman Emperor Probus, about the close of the third century, great attention was paid to the cultivation of the vine; it is supposed to have been planted on the banks of the Rhine, the Main, and the Moselle at that time, and to have been introduced into Britain. About the close of the tenth century, wine in considerable quantity and, it is said, of excellent flavor, was produced in England in the counties of Lincoln, Gloucester, and Somerset.

Fig. 7252.



*Wine-Ageing Apparatus.*

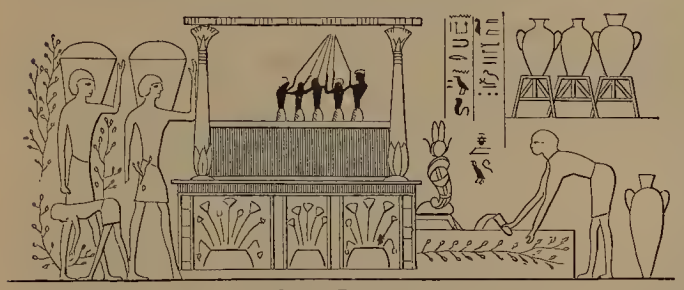
The importation of foreign wines into England commenced soon after the Norman Conquest, and was greatly increased by the acquisition of Guienne, under Henry II.

In the reign of Richard II., Spanish wines were common, and continued to grow in estimation, especially *sack*, which is the produce of the grape of Xeres, in Spain. Holingshed asserts that there were upward of eighty-six different kinds of wine imported from France and other countries into England in the sixteenth century.

On the enthronization of Neville, Archbishop of York, in 1553, upward of one hundred tuns of wine were consumed, and his predecessor is reported to have used, besides other wines, eighty tuns of claret yearly. At this period it was customary for the princes and nobles to bathe in wine.

Dioscorides, Acteus, and others among the ancients were

Fig. 7253.



*Grape-Press.*

acquainted with means of rendering the acid in spoilt wine imperceptible, and of stopping the fermentation or corruption by litharge. The introduction of sulphite of soda for this purpose is modern.

William, Count of Hennegan, Holland, and Zealand, prohibited the adulteration of wine in 1327, the first prohibition of the kind recorded; and the mixture of litharge with wine was made punishable by death, in the Duchy of Wurtemburg, in the year 1697.

Sulphurous-acid gas, produced by burning brimstone in the cask previous to the introduction of the wine, has a teudency to check fermentation and purify the wine, without imparting to it any deleterious properties.

In France and other wiue-producing countries, the old plan of treading out the grapes is still employed. This is performed by men who dance to the sound of music, and is preferred on accouut of there being no liability to crush the seeds and stalks of the bunches, which would impair the delicacy of the flavor.

Grape culture, for wine-making purposes, was, in this country, long almost exclusively confined to the banks of the Ohio, but is now practiced in localities, such as the shores of the Great Lakes, where it was formerly thought impracticable. Increased care and skill have developed varieties which may be relied on almost as a sure crop in many parts of the great central belt of the United States. California, however, appears destined to be the great wine-producing region of the future; the absence of frosts, and of excessive moisture at any time, giving it advantages not possessed elsewhere.

The gathering of the grapes in the Buena Vista Vineyard, California, is done in October and November. Men, with wooden boxes similar to a claret-box, and holding 50 pounds of grapes each, take a row of vines. They sever the grape-bunches with scissors made for this purpose, fill their boxes, and carry them to a wagon which attends upon every five men. Thirty-five boxes form a load, and a man will fill forty in a day. The boxes are elevated to the third story of the press-house. From a platform on this story the grapes are passed to the hopper of the crusher, which latter consists of two cylinders, 2½ feet long and 12 inches thick. A load is crushed in about six minutes, two men attending to feeding the machine. The grapes are crushed without mashing the seeds, aud fall into a box beneath, the juice running through the perforated false bottom and being conducted by spouts to the vats on the basement floor, where the *must* is allowed to settle for six hours, to remove impurities. The crushed grapes are removed to the press-box, which is 6 feet square and 4 feet deep. The follower is moved by an iron screw, 6 feet long and 5 inches in diameter, having a thread of slow pitch, to confer great power. It is said to deliver a pressure of 282,000 pounds. The side-pieces of the box are slipped in, and small intervals occur between each, allowing the escape of the *must*.

The press is filled with alternate layers of crushed grapes and wooden cubes. 6 inches of grapes followed by 3-inch cubes, and so on. It holds about 8,000 pounds of grapes, and the resultiug *must* joins that which preceded from the beforementioned box to the tanks on the ground-floor The pressing occupies seventy minutes. After settling in the tanks, it goes to the reservoir. It is then pumped into a tank and distributed to the fermenting-vats in the basement. Each of these vats holds 4,000 gallons. In from eight to fifteen days it clears, when the vat is filled with similar wine, and so remains till January. The wine is racked off three times the first year following the vintage, twice the second year, once the third year. It is then potable.

For red wine, the *must* is fermented on the skins.

The resulting stems, seeds, and skins are placed in a vat, covered with water, and fermented. The result is a wine from which brandy is distilled.

Vinegar and raisins are made on the same estate. See Haraszthy on "Grape Culture."

The wine-press of the Bible was a vat, in which the juice was expressed by the feet of men who tramped the fruit therein, staining their legs and garment with the color of the *must*. Says Jacob of Judah: "He washed his garuents in wine, and his clothes in the blood of grapes." Says Isaiah: "Wherefore art thou red in thine apparel, and thy garments like one that treadeth in the wine-fat." And again: "The treaders shall tread out no wine in *their* presses. I have made their vintage shouting to cease."

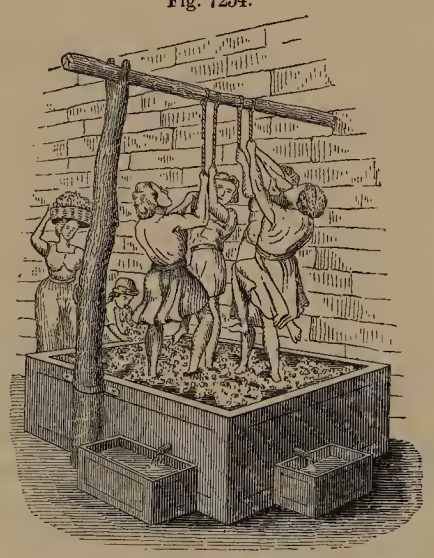
Wiue-presses among the ancient Egyptians were of different kinds. One kind was a bag, in which the grapes were put, and squeezed by means of twisting the bag. The accompanying illustration (Fig. 7253) is from a tomb at Beni-Hassan, and is so plain as to require no detailed description. In auother illustration, the ends of the bag are twisted in opposite directions by a pole at each end in the hands of two men.

In another illustration, taken from a tomb at Thebes, the various operations of treading the press and removing the *must* to the jars in which it stands to undergo fermentation are shown. After this process it was stored in *amphoræ*, or jars, which were closed with a lid, luted with clay or pitch, sealed, and then placed upright in the cellar.

The Romans had several different modes of expressing the juice. The grapes were crushed beneath a wooden beam, or in a press, the platen (*prelum*) of which was driven down upon the bed (*torcular*) by wedges. Sometimes a lever was used for tho purpose; a pair of screws are shown in a Pompeian painting. The oil-presses were of substantially similar construction.

The treading operation was also common and is represented

Fig. 7254.

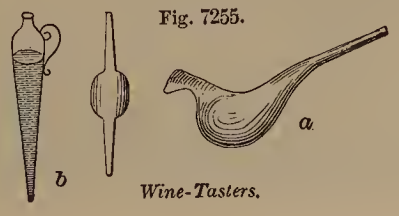


*Syrian Wine-Press (from Kitto).*

in a mosaic of a temple of Bacchus at Rome. It is substantially the same as that used in the Syrian wine-press of modern times, shown in the accompanying cut.

**Wine-tast'er.** A tube for withdrawing liquors from a jar, bottle, or cask. It has a larger opening at the lower end and a smaller one at the top. Being thrust in at the bung-hole of a wine-cask, for instance, it fills to the level of the wine outside of it. The upper end being then stopped by the finger,

Fig. 7255.




*Wine-Tasters.*

the tube is withdrawn and holds the liquid. A burette will answer for taking a sample from a bottle.

*a* in the accompanying cut shows a glass wine-taster discovered at Pompeii. The larger end was plunged into the amphora, and the small hole at the upper end stopped by the finger while the utensil was lifted out of the pot of wine.

*b* is the ordinary *taster* used by wine-merchants and others. Known as a *sampling-tube* or *velinche*. Sometimes called a *thief-tube*.

**Wing.** 1. A thin broad projection, as the wings of a gudgeon, which keep it from turning in the wooden shaft of which it forms the pivot. See WING-GUDGEON.

2. A vane of a rotating fan.

3. A sail of a windmill.

4. A side projection of a building on one side of the central or main portion.

5. A lateral extension of an abutment. See WING-WALL.

6. (*Fortification.*) The longer side of a crown or horn work uniting it to the main work.

7. The side, displayed portion of a dash-board.

8. A leaf of a gate or double door.

9. (*Plow.*) The laterally extending portion of a plowshare which cuts the bottom of the furrow.

10. (*Milling.*) A strip, commonly of leather, attached to the skirt of the runner to sweep the meal into the spout.

11. (*Shipbuilding.*) *a.* The overhang deck of a steamer before and abaft the paddle-boxes. The *wing-wale* extends from the paddle-beam to the side, and is also called the *sponson-rim*.

*b.* A passage along the inside of a ship, between the fore-and-aft cock-pits, to give the carpenters access to a leak. See WING-PASSAGE.

12. (*Hydraulic Engineering.*) *a.* An extension endways of a dam, sometimes at an angle with the main portion.

*b.* A side dam on a river shore to contract the channel. A notable instance of their use is mentioned on page 674, where the depth of water was increased in the channel of Red River to rescue a fleet of gun-boats.

13. A shoulder-knot or small epaulette.

14. One of the sides of the stage in a theater.

**Wing and Wing.** (*Nautical.*) Said of a *fore-and-aft* vessel going before the wind, with her foresail hauled over to one side, and mainsail to the other side.

**Wing-com'pass.** A joiner's compass with an arc-shaped piece which passes through the opposite leg, and is clamped by a set-screw.

**Wing'er.** (*Nautical.*) A smaller water-cask stowed in a vessel's hold where the sides contract fore and aft, and are relatively smaller than those amidships.

**Wing-gud'geon.** A metallic shaft forming a journal for water or other wheels having wooden axles. The wings are let into the ends of the wood and confined by wrought-iron bands put on hot, which become tight by shrinking.

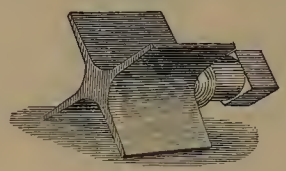
**Wing-pas'sage.** (*Shipbuilding.*) A passage-way around the cabins of the *orlop-deck* in ships of war, to allow access to the ship's side for repairing during action.

**Wing-rail.** (*Railway-engineering.*) A *guard-rail* at a switch. See GUARD-RAIL.

**Wing-tran'som.** (*Shipbuilding.*) A nearly straight and horizontal timber in the stern of a vessel, extending across between the fashion-pieces, in front of the stern-post and near its head. From it spring the timbers of the *counter*, or overhanging portion of the stern. The *wing-transom* is slightly rounded aft and upward, and is the uppermost transom of the stern-frame.

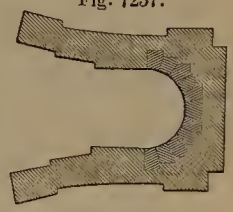
**Wing-wall.** One of the lateral walls of an abutment which form a support and protection thereto, to prevent the access of water to the rear and act as breast-walls to support the bank.

Fig. 7256.



*Wing-Gudgeon.*

Fig. 7257.



*Wing-Walls.*

**Wink'er.** (*Saddlery.*) A square or shield-shaped piece on each side of the bridle to confine the horse's attention ahead. A *blind*, *blinder*, or *blinker*.

**Wink'er-leath'er.** (*Saddlery.*) A heavy glazed leather used as the outside piece of a winker.

**Wink'er-plate.** (*Saddlery.*) A metallic plate slightly dished, used to give form and firmness to the winker.

**Wink'er-strap.** (*Saddlery.*) A strap attached to the crown-piece of a bridle, extending down the forehead a few inches, then branching off to each side, having the lower ends attached to the winkers; used to hold the latter in their proper position.

**Win'ning.** (*Mining.*) *a.* A new opening.

*b.* A portion of a coal-field to be worked. In British practice there are four systems: —

1. *Pillars* and *rooms*, called *post and stall*, where the pillars left bear such proportion to the coal excavated as is just adequate to the support of the superincumbent strata.

2. Working with *post and stall*, with extra-sized pillars, a part of which are removed when the coal is worked out and the regular working is over.

3 Working with *post and stall*, leaving very heavy pillars, which are all cut away when working backward towards the pit, allowing the ceiling to fall, following the retreating workmen.

4. The *long-way;* driving the gallery to the far end of the projected working, and then working backward, clearing out all the coal (for instance) and allowing the ceiling to cave in.

**Win'ning-head'way.** (*Mining.*) A headway driven to explore and open out a coal-seam.

**Win'now-ing-ma-chine'.** More often called a fanning-mill by those who *use* it, in this country. A machine in which grain, accompanied by chaff, dirt, cheat, cockle, grass-seeds, dust, straw, and other *foul*, either or all, is subjected to a shaking action on riddles and sieves in succession, the while an artificial blast of wind is driven against it on and through the sieves, and as it falls from one to another.

We derive it from Britain, which obtained it from Holland in 1710. It was introduced into Scotland by Meikle, the father of that Meikle who invented thrashing-machines.

The English word is derived from the idea of making an artificial blast by means of a fan; and the specific mechanical purpose is to separate grain from chaff by a blast of wind acting upon the latter, which is lighter than the grain. The oldest representations that we have of the process of winnowing are in the Egyptian tombs, where men with scoops are throwing the grain up into the air, so that the passing wind may drive off the chaff The shovel, the sieve, and the fan were the tools employed. "Clean provender which hath been winnowed with the shovel and with the fan." — Isaiah xxx. 24 "Like as grain is sifted with a sieve." — Amos ix 9. For this purpose, exposed situations on the tops of hills were chosen; and in the illustrations and Scripture references, it will be noticed that the tramping or thrashing was performed in the open air, contrary to our usual practice, but persevered in in the Eastern countries to this day. The climate in that part of the world is not so variable as our

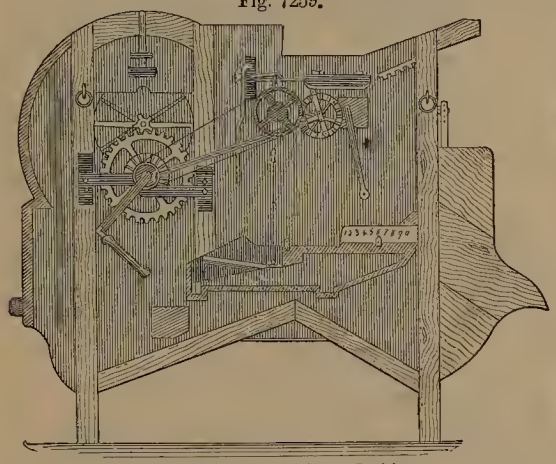
Fig. 7258.

*Winnowing in Egypt* (1500 B. C.).

own; and while Palestine and Syria were blessed with the early and latter rain, yet the interval was dry, and full dependence could be placed on the state of the weather. In Upper Egypt, rain was and is a rarity, as we learn from Herodotus, the father of history, and from modern geographers. In Lower Egypt, as the Mediterranean, the climate is more moist, as might be expected from its vicinity to so large a body of water.

We do not know at how early a date artificial devices were made use of to create a draft of air, but it was in the remote past, and the Scripture references are frequent. "His fan is in his hand, and he will thoroughly purge his floor"; that is, cleanse or clean, by separating foreign and useless matters; the fan is still used for this purpose in several forms. In some Eastern countries, the ordinary fan, on a large scale, is held in the hand, and made efficacious in blowing away the chaff as it and the grain descend from a riddle held aloft and shaken by another man. The writer still recollects one form in which the bars of a revolving reel were furnished with cloths and rotated by a hand-crank, the concern being six or seven feet long and having its bearings in posts of a frame standing upon the barn

Fig. 7259.



*English Winnowing-Machine.*

floor. It is among the histories of the machine that when it was introduced in Scotland, certain sensitive persons pronounced it an impious device, as "it raised a wind when the Lord had made a calm." This is another inflection of the old opposition that met Kepler and Galileo

Fig. 7259 illustrates a machine, still in use, invented by Gooch of Northampton, England, in 1800. It embraces the important features of the more modern machines: the rotating fan, the shaking-riddle, and sieves for sorting the grain and separating extraneous matters. See also FANNING-MILL.

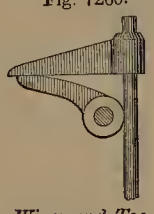
**Winze.** (*Mining.*) *a.* A shaft sunk from one level to another for communication or ventilation.

*b.* A wheel and axle for hoisting.

**Wip'er.** 1. (*Valve Motion.*) A cam which projects from a horizontal shaft and acts periodically upon a toe whose elevation lifts the valve-rod and puppet-valve.

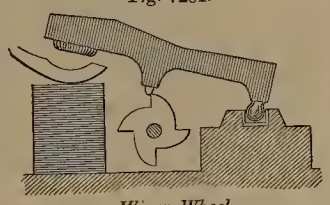
The *wiper* has usually a rotary reciprocation; when the rotary motion is continuous, it becomes a wiper-wheel, which may have a number of cams acting consecutively in the course of a revolution. See also WIPER-WHEEL.

Fig. 7260.



*Wiper and Toe.*

Fig. 7261.



*Wiper-Wheel.*

2. (*Small-arms.*) A steel implement having two twisted branches; it is screwed on the end of the ramrod, and carries a piece of cloth or some tow for cleaning out the bore of a musket. One accompanies each musket issued to the troops. Those of large size, used for cleaning out cannon, are fixed on a wooden staff, and are called *worms.*

The wiper for ordnance is called a *sponge.*

**Wip'er-wheel.** A cam-wheel placed below the shank of a tilt-hammer to lift it periodically, allowing it to fall by its own weight.

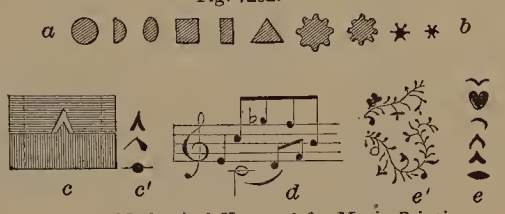
The motion is found in many other machines, such as stamping-mills for ore and stone, etc.

**Wire.** A metallic rod, thread, or filament of small and uniform diameter. The largest size, numbered 0000, of the Birmingham wire-gage, has a diameter of .454 inch; but smaller sizes even than this, except when drawn out to considerable lengths, are generally known as bars or rods. See WIRE-GAGE.

Lead wire for the manufacture of bullets may considerably exceed the above diameter.

Wire is usually cylindrical, but it is also made of various other forms, as oval, half-round, square, and triangular, and of more complicated shapes for small pinions; for forming the pattern on blocks used in calico-printing, and for other purposes. See PINION-WIRE.

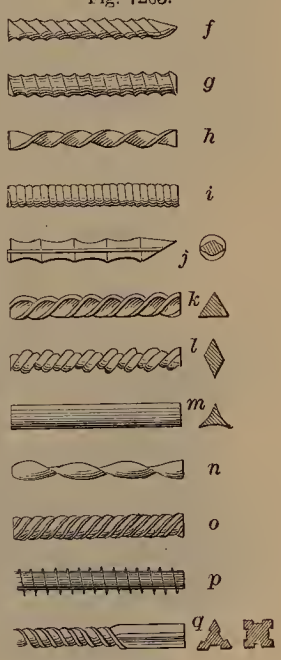
Fig. 7262.




*Wires for Mechanical Uses and for Music-Printing.*

Wire was originally made by beating the metal into thin plates, and then cutting it into strips and rounding it with a hammer. The sacerdotal dress of Aaron had interwoven shreds of gold, which were obtained by this process, doubtless. The interweaving of gold threads into dress-stuffs is mentioned by Pliny, who ascribes the invention to King Attalus; but it was practiced in Egypt and in Oriental countries before the era of that monarch.

Fig. 7263.




*Wires for Shoe-Fastenings, etc.*

Gold wire is found attached to rings bearing the date of Osirtasen I., 1740–1696 B. C.

In ancient times, and, indeed, during the Middle Ages, gold and silver were almost, if not the only, metals which were formed into wire. In the reign of Elizabeth, iron and brass wire were both manufactured and imported into England. Copper wire was first made in England in the seventeenth century.

Beckman states that "as long as the work of wire-making was performed by the hammer, the artists of Nuremberg were called *wire-smiths;* but after the invention of *drawing* wire, they were called *wire-drawers* or *wire-millers.* Both these appellations occur in the history of Augsburg as early as the year 1351, and in that of Nuremberg in 1360; so that according to the best information I have been able to obtain, I must class the invention of the *drawing-iron,* or proper wire-drawing, among those of the fourteenth century."

The art was not introduced into England till the sixteenth century, but had attained great excellence in the reign of Charles I. See DRAW-PLATE.

This does not fully indorse the ascription of the invention to Rodolph of Nuremberg, A. D. 1410, but he may have much improved the art; mills were erected in Nuremberg, 1563. The first wire-mill in England was erected at Mortlake, in 1663.

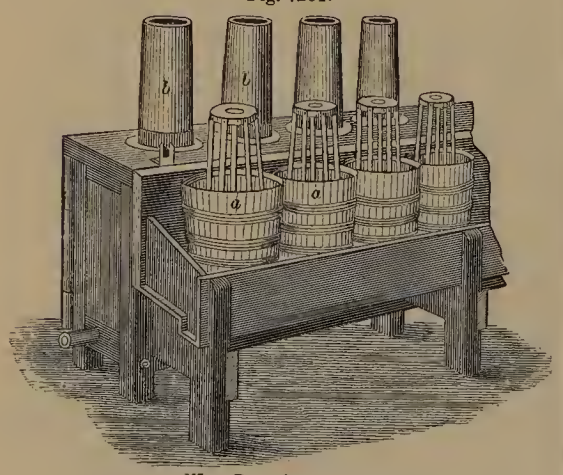
*a* (Fig. 7262) shows forms of round, oval, half-round, square, and triangular wires.
*b*, pinion-wires for watch-makers.
*c c'*, draw-plate and music wire.
*d*, unsie, as printed with wire type.
*e e'*, fancy wires made for calico-printing rollers; example of the effect of association of the various patterns.
*f g h* (Fig. 7263), Godfrey's wire shoe-peg.
*i*, Wickersham's short-twist round-thread wire.
*j*, Blake and Libby's lenticular wire-nail.
*k l*, Smith's polygonal metallic peg.
*m n*, Townsend's polygoual wire, before and after twisting.
*o p*, Townsend's wire; thread raised by pressure.
*q*, Dudley's angular wire, with grooved faces.
*r*, mode of making Dudley's wire.
*s*, Proctor's wire, with serrated edges for burring and feed-cylinders.
*t*, Beatty's flat perforated wire.
*u*, Bigelow's shoe-wire, circumferential grooves; uo thread.

The general process of manufacturing iron wire on a considerable scale is as follows: —

The rods, from ¼ to ½ inch in diameter, received from the rolling-uills in bundles, are heated and rerolled in grooved rollers, oue above the other, so that the rod runs from the first roll to the second, and so on, without reheating. The rollers run with great rapidity, reducing the rod to a coarse wire which is then passed through the successive holes in the draw-plate. The DRAW-PLATE (which see) is a flat piece of hard steel having holes corresponding to the various numbers or sizes of wire.

The best are made of a combined plate of highly tempered steel and wrought-iron. The holes are tapering, the smallest opening being on the steel side through which the wire first enters. For drawing very fine wire, in which great uniformity is required, perforated rubies or other hard stones are fixed in the plate. The wire is annealed and drawn cold. The machinery includes a draw-beuch, which lifts the wire from a reel to the first hole in the draw-plate, from which it passes to another reel or drum on which it is wound to be again drawn through the next smaller hole in the draw-plate, and so on down until it is reduced to the required size. It requires to be anuealed several times during the process. Grease aud wax are used for lubricating. The plan of covering brass wire with a film of copper has been lately introduced; this proves of great service iu drawing, and can be wholly removed at the last annealiug. The rapidity of drawing is regulated according to the ductility of the metal and size of the wire; as it becomes attenuated the speed may be increased; that used for iron and brass varies from twelve to forty-five inches per second according to size, while the finer kinds of gold and silver wire are drawn at the rate of sixty or seveuty inches per second.

Fig. 7264.



*Wire-Drawing Frame.*

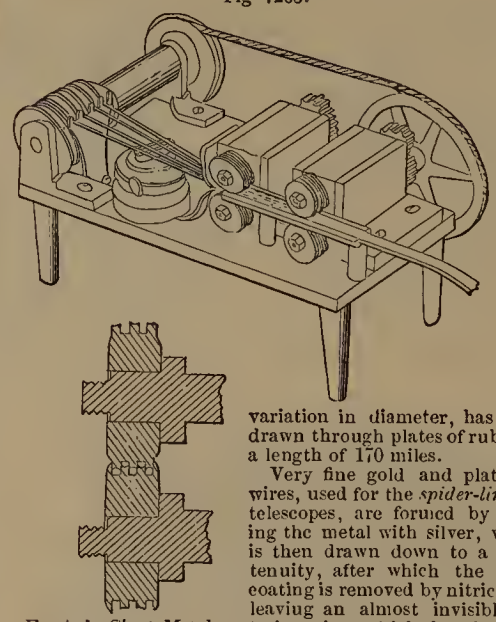
Fig. 7264 illustrates the wire-drawing frame employed for sizes smaller than No. 19; *a a* are tubs in which are placed a series of upright reels for containing the coils of wire. One end of the wire is attached to one of the drums *b*, revolved by suitable gearing beneath, by which it is drawn through the die-plate in the manner previously described. The frame may be provided with any desired nuuber of drums; but four are shown in the figure.

Fowler, January 5, 1869, makes wire of sheet-metal, cutting it into strips between pairs of rollers with interlocking sharp-edged ridges and grooves. The lower figure shows, on an enlarged scale, a vertical section through a pair of rolls. See also his patent, No. 87,557.

A similar process is used in cutting shirrs from a ribbon of india-rubber. See Fig 4489

Silver wire, in which the most delicate tests could detect no variation in diameter, has been drawn through plates of rubies to a length of 170 miles.

Fig 7265.



*Fowler's Sheet-Metal Wire-Machine.*

Very fine gold and platinum wires, used for the *spider-lines* of telescopes, are formed by coating the metal with silver, which is then drawn down to a great tenuity, after which the silver coating is removed by nitric acid, leaviug an almost invisible interior wire, which has been so attenuated that a mile in length weighed only a grain.

L Chelot, a Belgian manufacturer, makes a pentagonal wire.

Threaded wire — cable wire — for boots and shoes, made under patents: —

Prosser, 116,218, June 20, 1871.
Wickersham, 118,318, August 22, 1871.

See also Fig. 3568, page 1648.

The modern uses of wire are almost innumerable: —

Telegraphy, cables for suspension-bridges, ropes for ships' rigging, hoisting, etc; fences, strings for musical instruments, hoop-skirts, pins and needles, shoe-sole fastenings (see Fig. 7263, are some of its manifold applications. Twined broom-wire is a considerable item. Culinary and table utensils are extensively made from white-wire. It is used in the manufacture of cards, heddles, reeds for looms, and, when woven, is employed in flour, paper, and other machinery. Woven wire of iron, brass, and copper is made into baskets, screens, sieves, cages, dish-covers, and a great variety of other objects.

Electrical, magnetic, philosophical, and other scientific instruments also consume considerable quantities of wire.

Another great use for wire occurred in the demand for tempered flat steel wire for crinolines. At the outset this wire cost three dollars a pound, because in tempering it was necessary to wind the flat wire in volute coils kept apart by interlaced iron wires, the coils being then carefully heated in a furnace, and then plunged into a hardening bath. In August, 1858, Henry Waterman patented a plan of drawing the wire lengthwise from the fire through the hardening liquid, and by this means reduced the cost from three dollars a pound to three cents. Waterman's process of tempering wire is said to have brought him $83,000 over all expenses.

**Wire-an-neal'ing.** Softening a wire by heat after it has been hardened by drawing or by exposure to cold after heating.

G. I. Washburn, October 7, 1862, patented a process for annealing wire in an artifical atmosphere in the pot or vessel, whereby he is enabled to control the degree of or prevent oxidation of the iron or steel being annealed. The object is to keep it bright and prevent scaling, and the consequent necessity for the acid bath.

A suggestion published in 1868 gives some detail of a plan for excluding the atmosphere. "Large wire as well as small can be annealed, and still retain the brightness it possessed, after passing through the drawiug-dies. The process is to pack the coils in cylindrical cast-iron pots with double lids, the outer one resting on a projection or rim half an inch below the top of the pot, leaving room between the outside of the inuer lid and the inside of the outer, for dry sand to exclude the atmosphere. The pots should not be opened until quite cool after the heating process, otherwise the atmosphere will so far oxidize the surface as to turn the color to a blue or black."

See pateuts: —

| No. | Date. | No | Date. |
|---|---|---|---|
| 21,286. | April 24, 1858. | 65,699. | June 11, 1867. |
| 131,680. | September 7, 1872. | 65,215. | May 28, 1867. |
| 131,681. | September 7, 1872. | 70,881. | November 12, 1867. |
| 65,481. | June 4, 1867 | 26,143. | November 15, 1859. |
| 31,361. | February 5, 1861. | 90,314. | May 15, 1869. |

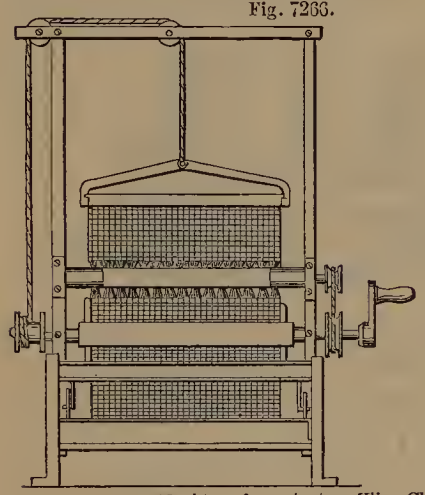
**Wire-car'tridge.** A cartridge for fowling in which the charge of shot has wire ligaments.

**Wire-cloth.** A fabric whose woof and weft are of wire; the size of the wire, the shape and sizes of the meshes, being adapted to the uses of the completed screen, sifter, or sieve, or the character of the machine in which it is to be used. Besides the purpose of separating materials of different finenesses, screens are used in hat-forming machines and bran-dusters (Fig. 2431); also as fire and window screens and guards, kiln-floors, panels of fences, meat-safes, dish-covers, bed-bottoms, lamp-covers, as in the safety-lamp. See also patents: —

| No. | Name and Date. |
|---|---|
| 5,005. | Jenkins, March 6, '47 (crimping). |
| 25,578. | Nutting, Sept. 27, '59. |
| 49,556. | Zerns, August 8, '65 (crimping). |
| 92,949. | Fisk, July 27, '69. |
| 103,553. | Beck, Oct. 25, '70. |
| 117,272. | Goodhue, July 25, '71. |
| 118,283. | Seitzinger, Aug. 22, '71. |
| 120,150. | Gardner *et al.*, Oct. 24, '71. |
| 121,111. | Kohn, Nov. 21, '71. |
| 124,286. | Peters, Mar. 5, '72. |
| 126,081. | Parker, April 23, '72. |
| 127,227. | Edge, May 28, '72 (weaving wire-tubes). |
| 128,438. | Turnbull, June 25, '72. |
| 131,885. | Le Ren, Oct. 1, '72. |
| 132,528. | Farley, Oct. 29, '72. |
| 133,886. | Peters, Dec. 10, '72. |
| 138,491. | Field, May 6, '73. |
| 139,077. | Parker, May 20, '73. |
| 140,160. | Peters, June 24, '73. |

See also patents for making wire-sieves.

Fig. 7266.



*Machine for painting Wire-Cloth.*

One of the most important uses of wire-cloth is for the webs in paper-making machines. These have from 2,300 to 6,400 meshes to the square inch. They are woven in lengths of 30 to 40 feet, the widths varying from 4 to 10 feet, and their ends are joined together so as to form endless bands, known as "paper-machine wire."

Wire of sufficient fineness can, however, be woven so as to have over 19,000 perforations or *holes* to the square inch. Sieves of this fineness are occasionally used for sifting impalpable powders.

**Wire-cloth Crimp'er.** The wire-crimper is for giving the dentations to heavy wire before weaving. See patent 118,283, August 2, 1871. The crimping of the cloth is performed in a machine also.

**Wire-cloth Loom.** One for weaving warp of wire with a weft of wire. Its construction varies somewhat with the size and pliability of the wire.

See patents: —

| No. | Date. |
|---|---|
| 138,090. | April 22, 1873. |
| 14,000. | December, 25, 1855. |
| 86,233. | January 26, 1869. |
| 36,377. | September 2, 1862. |
| 10,546. | February 21, 1854. |
| 131,584. | September 24, 1872. |
| 18,320. | October 6, 1857. |
| 4,873. | December 5, 1846. February 23, 1826. |

**Wire-cloth Paint'er.** A machine for painting wire-cloth in the web. It is passed through a trough containing paint, between pressure-rollers and under a rotating brush.

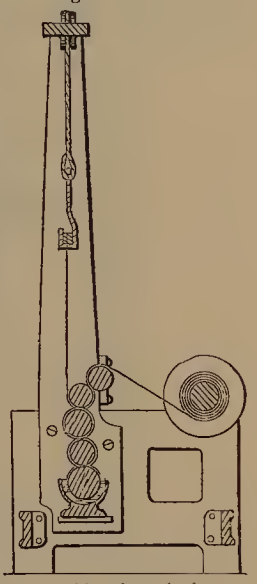
See also patents: —

| No. | |
|---|---|
| 124,569. | March 12, 1872. |
| 14,320. | February 26, 1856. |
| 130,350. | August 6, 1872. |

**Wire-cloth Print'er.** A machine for printing figures on wire-cloth. The arrangement consists of a roller having the figures to be painted engraved thereon, and a pressure-roll, between which rollers the wire-cloth is passed. The lower roll supplies paint to the engraved roll.

**Wire-cov'er-ing Machine'.** A machine for covering wire with thread or other smaller wire.

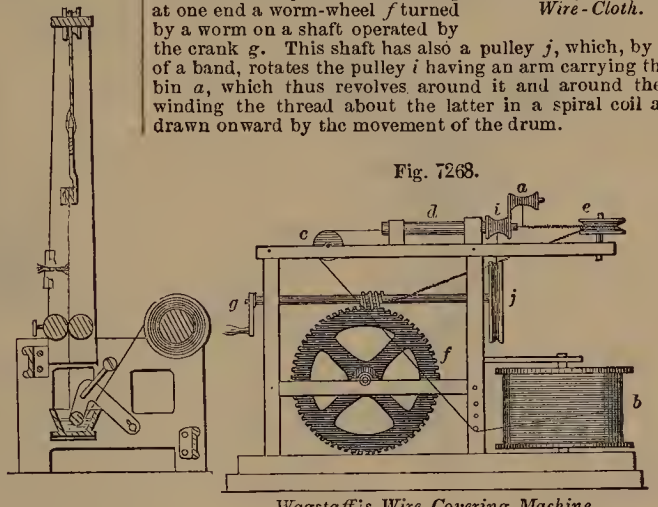
Fig. 7267.



*Machine for printing Wire-Cloth.*

In Wagstaff's (Fig. 7268) the thread is carried on a bobbin *a*, and the wire to be covered is wound upon a drum *b*, whence it passes over a pulley *c*, through a tube *d*, around a grooved pulley *e*, and is wound upon a drum having at one end a worm-wheel *f* turned by a worm on a shaft operated by the crank *g*. This shaft has also a pulley *j*, which, by means of a band, rotates the pulley *i* having an arm carrying the bobbin *a*, which thus revolves around it and around the wire, winding the thread about the latter in a spiral coil as it is drawn onward by the movement of the drum.

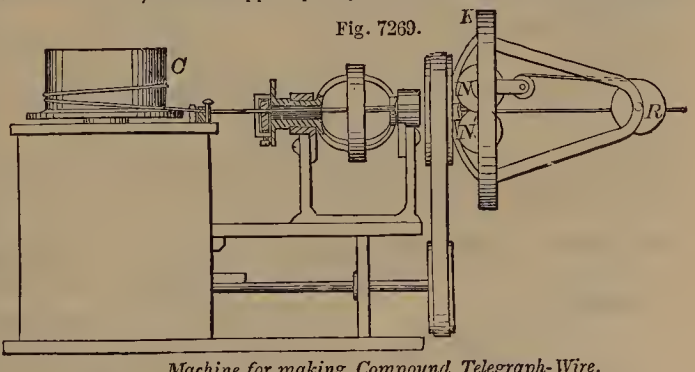
Fig. 7268.




*Wagstaff's Wire-Covering Machine.*

In Fig. 7269 a thin ribbon of metal from the spool *R* is drawn between the grooved rollers *N N'*, carried by the rotating-head *K*, and is wrapped spirally round the wire. The two are drawn together through the draw-plate which unites them, and are wound upon the drum *C*.

Fig. 7269.



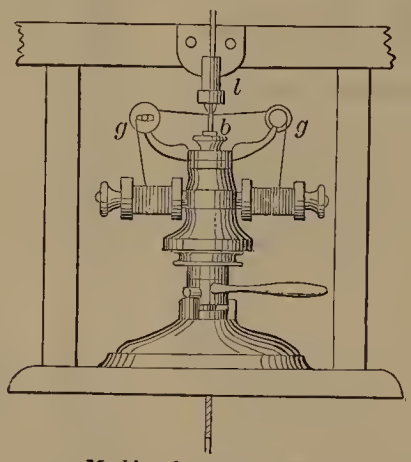

*Machine for making Compound Telegraph-Wire.*

Fig. 7270 is a machine for covering wire with fine wire. The hollow fixed head *l* for the wire is independent from, but in line with, the hollow axis *b* of the revolving head, which carries spools of fine wire to be wound around the wire which is fed along the axis of revolution. The tension is obtained by passing the wire around grooved rollers *g g*.

See also patents: Loft, No. 27,456, March 13, 1860; Reinwarth, No. 154,342, August 25, 1874 (covering piano strings).

In Sperry's machine (Fig. 7271) the wire to be covered is drawn upward through the hollow spindle *a*; a sleeve driven

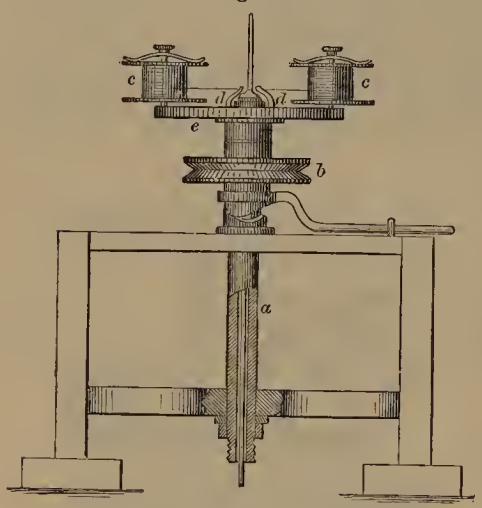
Fig. 7270.




*Machine for covering Wire.*

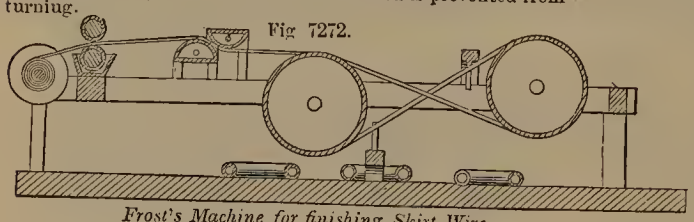
by a pulley *b* turns on the spindle as an axis and carries two spools *c c* containing the covering wire; this is conducted between two guides *d d* and applied spirally to the wire as it advances by the revolution of the table *e* on which the spools are held by spindles, while the wire to be covered is prevented from turning.

Fig. 7271.




*Sperry's Wire-Covering Machine.*

Fig. 7272.

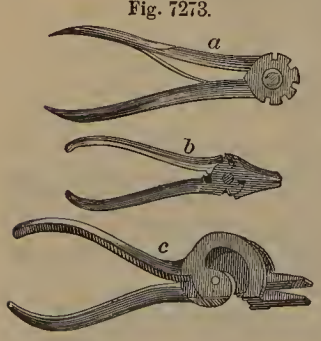


*Frost's Machine for finishing Skirt-Wire.*

Fig. 7272 shows a machine for sizing and finishing covered skirt-wire. The covered braided wire is passed from the supply-reel through the sizing medium, and back and forth over heated drums, and thence back through the sizing medium again to the second coat, and so on, as many times as may be desirable to apply successive coats of size, one over the other.

See also Chesney's patent, No. 40,244, October 13, 1863.

Fig. 7273.




*Wire-Cutting Pliers.*

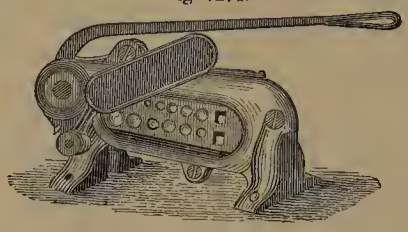
**Wire-cut'ter.** A nippers for cutting off wire.

*a* (Fig. 7273). Each leg of the cutter terminates in a disk having corresponding openings to receive the wire, which is sheared between their edges when the legs are brought together.

*b*. The edges of the jaws have corresponding slots, with cutting edges, into which the wire is inserted. The instrument is also used as a plyer.

*c*. The upper jaw is slotted, and the lower one works within it; the two serve as a plyer. The under side of the lower jaw has a cutting edge next to the joint, which severs the wire.

Fig. 7274.

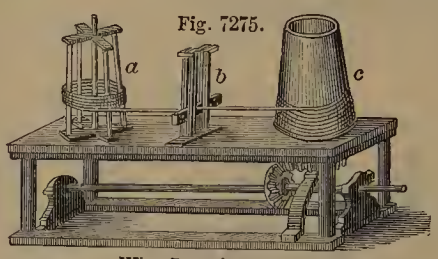


*Wire-Cutter.*

**Wire-draw.** To reduce in transverse size by drawing through an eye in a draw-plate.

**Wire-draw'ing Bench.** Iron wire, previously reduced to a diameter of $\frac{1}{4}$ to $\frac{1}{16}$ inch, is drawn down by the apparatus (Fig. 7275), consisting of a reel *a* on which the wire to be reduced is wound, a draw-plate and stand *b*, and a conical drum *c*. The end of the wire is pointed and reduced sufficiently to pass through the proper aperture in the draw-plate, and is secured to a hook on the drum *c*, which is then set in motion by bevel-gearing.

Fig. 7275.




*Wire-Drawing Bench.*

**Wire-drawn.** (*Steam.*) The condition of steam when the pipes or ports leading to the cylinder have not sufficient carrying capacity.

**Wire-fas'ten-ing.** A tie for a cork in a bottle of champagne, soda-water, or other effervescing liquor.

"Henry W. Putnam's wire-fastening for bottle-stoppers, patented in 1864, was a slight and simple thing sold for a dollar and a half a gross, or a trifle more than a cent apiece. But the labor it saved in the tying of corks in soda-water bottles alone amounted to nine millions of dollars in nine years, estimating the labor at one dollar and twenty-five cents per day. The inventor made twenty thousand dollars from it in the same time."

**Wire-feed Screw-ma-chine'.** A machine for making screws from a continuous length of wire.

Admirable examples are to be found in the American Watch Company's works at Waltham, where jewel and other screws are made by perfectly automatic operations from wire fed from spools.

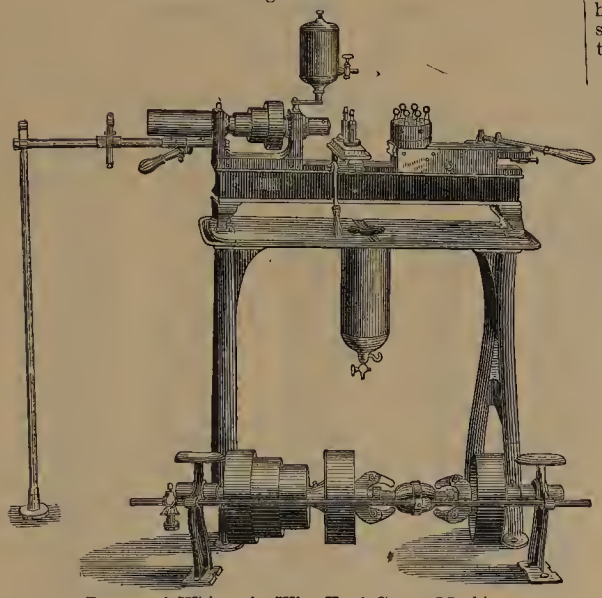
Fig. 7276 shows one on a larger scale by Pratt and Whitney, of Hartford, Conn.

**Wire-fence.** Hurdles of woven wire, or wire stretched from post to post.

Fig. 7277 shows one form in which the sections are strained between movable self-supporting posts.

In Fig. 7278, the wires are attached to the corner-posts, and passed through all the uprights and the capstan-blocks at the midlength of the fence. The panels have strut-bars at top, and a triangular trestle supports each corner transversely. The capstan-blocks are separate, so as to allow the independent

Fig. 7276.



*Pratt and Whitney's Wire-Feed Screw-Machine.*

tightening of each wire, and are turned by radial arms which are secured by wires to the nearest post.

Fig. 7279 is an iron post for wire-fences. The posts are made of strap-iron bent around at the top and spread at the bottom; the sides are connected by stay-rods, and are braced at the angle near the foot by angular-flanged frames.

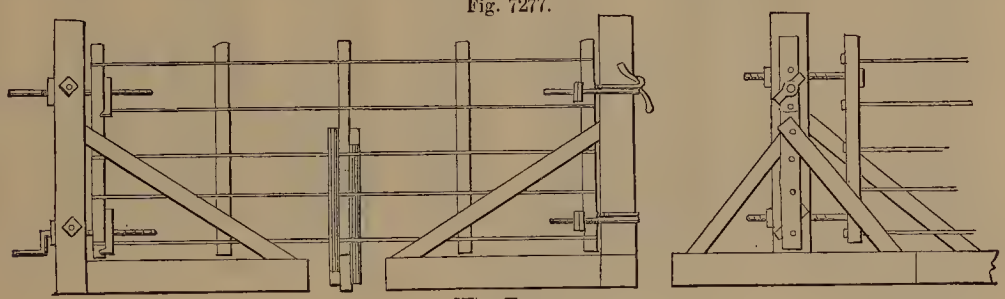
Fig. 7280 is a machine for making combined wood and wire fence. The batten is suspended by rods which have bearings in notches in the frame; it can be suspended parallel to the heddles or in an oblique position to enable the fence to be constructed so as to set on uneven ground. A knife is attached to the frame of the loom to sever the superfluous ends of the poles.

See patents: —

| Name and Date. | No. |
|---|---|
| Clinger, September 13, 1859 | 25,387. |
| Esminger, December 8, 1868 | 84,810. |
| Gale, August 18, 1863 | 39,563. |
| Hill, June 18, 1872 | 128,145. |
| Jenkins, February 14, 1849 | 6,106. |
| Knapp, Juue 7, 1864 | 43,082. |
| Lakins, August 27, 1873 | 146,246. |
| Little, June 24, 1873 | 140,147 and 159,691. |
| Mendell, August 3, 1869 | 93,326. |
| Meriweather, November 8, 1853 | 10,211. |
| Nicholson, April 25, 1871 | 114,029. |
| Norcross, January 10, 1865 | 45,852. |
| Rappleye, July 4, 1871 | 116,755 and 136,094. |
| Reyman, September 29, 1857 | 18,301. |
| Rose, May 13, 1873 | 138,763. |
| Sisson, April 25, 1871 | 114,057. |
| Smith, June 25, 1857 | 66,182. |
| Speakman, January 16, 1872 | 121,862 and 153,390. |
| Wakefield, March 14, 1871 | 112,658. |
| Walker, May 29, 1853 | 9,642. |
| Wilson *et al.*, December 6, 1870 | 109,858. |
| Patterson, July 14, 1868 | 79,854. |
| Darlington, August 11, 1874 | 154,024. |
| Glidden, November 24, 1874 | 157,124. |
| Haish, January 20, 1874 | 146,671 and 164,552. |
| Hall, December 1, 1874 | 157,391. |
| Merrill, December 29, 1874 | 155,538 and 164,576. |
| Withers, October 6, 1874 | 155,603. |
| Ellwood, May 11, 1875 | 163,169. |
| McClellan, November 2, 1875 | 169,265. |
| Seabury, November 10, 1875 | 170,024. |
| Stover, June 29, 1875 | 164,947. |

**Wire-gage.** A gage for measuring the thickness of wire and sheet-metals. It is usually a plate

Fig. 7277.



*Wire-Fence.*

of steel having a series of apertures around its edge, each corresponding in width to the diameter of wire of a certain number.

Wire-gages are commonly of oblong form, and are formed by drilling a number of holes near the edge of the plate; notches are then sawed from the edge into the holes, saws of the width proper for each being used; and, lastly, the little parallel plates of steel termed drifts are driven into the notches, to smooth and make them of uniform width.

The circular wire-gage, which is neater and more compact than the ordinary kind, is now very generally used (Fig. 7281).

Holtzapffel remarks that "the Birmingham and other gages seem to have originated, in great measure, accidentally, or almost by the eye alone, and without any attempt at system, either as regards the values of the intervals between the successive measures or numbers, or their correspondence with the subdivisions of the inch."

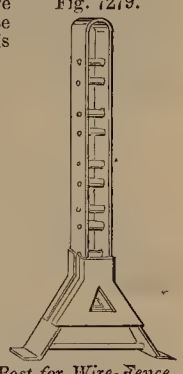
The Birmingham gage is the best known and most generally used in England, and was in this country until a more systematic gage was devised. It is so called from its being employed as the standard at Birmingham, always the great headquarters of the iron trade.

The defects indicated by Holtzapffel have led to attempts to introduce gages based upon more correct principles, in which a greater degree of uniformity in the progressive differences between the various sizes of wire should be observed. Fig. 7281 is a gage of this kind, prepared by Messrs. Brown and Sharp of Providence, R. I.

The wire is entered in a tapering slit in the gage, which has marks at intervals indicating the number of the wire which just fills the width of the slit at that point.

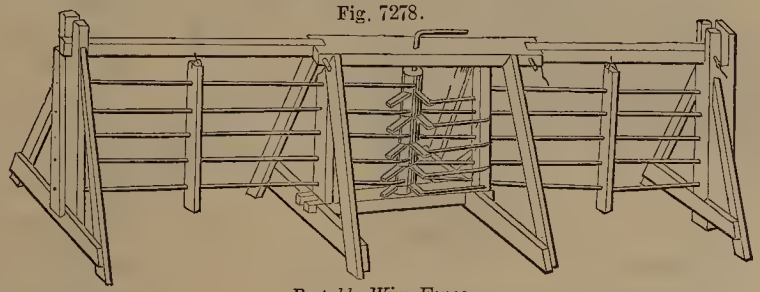
A new set of numbers and dimensions are also adopted. The difference between these and those of the old, or Birmingham, gage is shown in the following table: —

Fig. 7279.



*Post for Wire-Fence.*

Fig. 7278.



*Portable Wire-Fence.*

## Weight of Wrought-Iron, Steel, Copper, and Brass Wires and Plates.

*Diameters and Thickness determined by American Gage of Brown, Sharpe, & Co.*

| No. of Gage. | Size of each No. | Weight of Wire per 1,000 lineal Feet. | | | | Weight of Plates per square Foot. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Wrought-Iron. | Steel. | Copper. | Brass. | Wrought-Iron. | Steel. | Copper. | Brass. |
| | Inch. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. |
| 0000 | .46000 | 560.74 | 566.03 | 640 51 | 605.18 | 17.25 | 17.48 | 20.838 | 19 688 |
| 000 | .40964 | 444.68 | 448.88 | 507.95 | 479.91 | 15.3615 | 15.5663 | 18 557 | 17.533 |
| 00 | .36480 | 352 66 | 355 99 | 402.83 | 380.67 | 13 68 | 13 8624 | 16.525 | 15.613 |
| 0 | .32486 | 279 67 | 282.30 | 319.45 | 301.82 | 12.1823 | 12.3447 | 14.716 | 13 904 |
| 1 | .28930 | 221.79 | 223 89 | 253.34 | 239 35 | 10.8488 | 10.9934 | 13 105 | 12.382 |
| 2 | .25763 | 175.89 | 177.55 | 200.91 | 189.82 | 9 6611 | 9.7899 | 11.671 | 11 027 |
| 3 | .22942 | 139 48 | 140.80 | 159.32 | 150 52 | 8.6033 | 8 7180 | 10 393 | 9 8192 |
| 4 | .20431 | 110.62 | 111.66 | 126.35 | 119.38 | 7.6616 | 7.7638 | 9.2552 | 8 7445 |
| 5 | .18194 | 87.720 | 88.548 | 100.20 | 94.666 | 6.8228 | 6 9137 | 8.2419 | 7 787 |
| 6 | .16202 | 69.565 | 70.221 | 79.462 | 75 075 | 6 0758 | 6.1568 | 7.3395 | 6.9345 |
| 7 | .14428 | 55.165 | 55.685 | 63.013 | 59.545 | 5.4105 | 5.4826 | 6 5359 | 6 1752 |
| 8 | .12849 | 43.751 | 44 164 | 49.976 | 47.219 | 4.8184 | 4.8826 | 5.8206 | 5.4994 |
| 9 | .11443 | 34.699 | 35.026 | 39.636 | 37.437 | 4 2911 | 4.3483 | 5 1837 | 4.8976 |
| 10 | .10189 | 27.512 | 27.772 | 31.426 | 29.687 | 3.8209 | 3 8718 | 4.6156 | 4 3609 |
| 11 | .090742 | 21.820 | 22.026 | 24.924 | 23.549 | 3.4028 | 3.4482 | 4.1106 | 3.8838 |
| 12 | .080808 | 17.304 | 17 468 | 19.766 | 18.676 | 3.0303 | 3 0707 | 3 6606 | 3 4586 |
| 13 | .071961 | 13.722 | 13 851 | 15.674 | 14.809 | 2 6985 | 2 7345 | 3 2598 | 3 0799 |
| 14 | .064084 | 10 886 | 10.989 | 12.435 | 11 746 | 2.4032 | 2.4352 | 2 9030 | 2 7428 |
| 15 | .057068 | 8.631 | 8.712 | 9.859 | 9 315 | 2.1401 | 2.1686 | 2.5852 | 2.4425 |
| 16 | .050820 | 6.845 | 6.909 | 7.819 | 7 587 | 1.9058 | 1.9312 | 2.3021 | 2.1751 |
| 17 | .045257 | 5.427 | 5.478 | 6.199 | 5.857 | 1.6971 | 1.7198 | 2.0501 | 1 937 |
| 18 | .040303 | 4 304 | 4.344 | 4.916 | 4.645 | 1.5114 | 1.5315 | 1.8257 | 1.725 |
| 19 | .035890 | 3.413 | 3.445 | 3 899 | 3 684 | 1.3459 | 1.3638 | 1.6258 | 1 5361 |
| 20 | .031961 | 2.708 | 2.734 | 3.094 | 2 920 | 1.1985 | 1.2145 | 1.4478 | 1.3679 |
| 21 | .028462 | 2 147 | 2 167 | 2.452 | 2.317 | 1.0673 | 1.0816 | 1 2893 | 1.2182 |
| 22 | .025347 | 1.703 | 1.719 | 1.945 | 1.838 | .95051 | .96319 | 1.1482 | 1.0849 |
| 23 | .022571 | 1.350 | 1.363 | 1.542 | 1 457 | .84641 | .8577 | 1.0225 | .96604 |
| 24 | .020100 | 1.071 | 1.081 | 1.223 | 1 155 | .75375 | .7638 | .91053 | .86028 |
| 25 | .017900 | .8491 | .8571 | .9699 | .9163 | .67125 | .6802 | .81087 | .76612 |
| 26 | .01594 | .6734 | .6797 | .7692 | .7267 | .59775 | .60572 | .72208 | .68223 |
| 27 | .014195 | .5340 | .5391 | .6099 | .5763 | .53231 | .53941 | .64303 | .60755 |
| 28 | .012641 | .4235 | .4275 | .4837 | .4570 | .47404 | .48036 | .57264 | .54103 |
| 29 | .011257 | .3358 | .3389 | .3835 | .3624 | .42214 | .42777 | .50994 | .48180 |
| 30 | .010025 | .2663 | .2688 | .3042 | .2874 | .37594 | .38095 | .45413 | .42907 |
| 31 | .008928 | .2113 | .2132 | .2413 | .2280 | .3348 | .33926 | .40444 | .38212 |
| 32 | .007950 | .1675 | .1691 | .1913 | .1808 | .29813 | .3021 | .36014 | .34026 |
| 33 | .007080 | .1328 | .1341 | .1517 | .1434 | .2655 | .26904 | .32072 | .30302 |
| 34 | .006304 | .1053 | .1063 | .1204 | .1137 | .2364 | .23955 | .28557 | .26981 |
| 35 | .005614 | .08336 | .08445 | .0956 | .09015 | .21053 | .21333 | .25431 | .24028 |
| 36 | .005000 | .06625 | .03687 | .0757 | .0715 | .1875 | .19 | .2265 | .2140 |
| 37 | .004453 | .05255 | .05304 | .06003 | .05671 | .16699 | .16921 | .20172 | .19059 |
| 38 | .003935 | .04166 | .04205 | .04758 | .04496 | .14869 | .15067 | .17961 | .1697 |
| 39 | .003531 | .03305 | .03336 | .03775 | .03566 | .13241 | .13418 | .15995 | .15113 |
| 40 | .003144 | 02620 | .02644 | .02992 | .02827 | .1179 | 11947 | .14242 | .13456 |
| Specific gravity..... | | 7.7747 | 7 847 | 8.880 | 8.386 | 7.200 | 7 296 | 8 698 | 8 218 |
| Weight per cubic foot.. | | 485.874 | 490.45 | 554.988 | 524.16 | 450. | 456. | 543.6 | 513.6 |

The sizes of needle-wire bear no relation to those of the wire-gage (Birmingham).

| | Nos. |
|---|---|
| Needle-wire ..... | 1, 2, 2½, 3, 4, 5, up to 21. |
| Birmingham gage.. | 18½, 19, 19½, 20, 21, 22, up to 38. |

So also of piano-forte wire: —

| | |
|---|---|
| Music-wire..... | 6, 7, 8, 9, 10, 11, 12, 14, 16, 18, 20. |
| Birmingham gage.. | 26, 25½, 25, 24½, 24, 23½, 23, 21, 21, 20, 19. |

Nos. 1 to 5 music-wire are now disused since the framing of pianos has been so much strengthened.

The compound tool (Fig. 7282) has two legs turning on a rule-joint *A*. The inner side of the leg *B* is notched to serve as a wire-gage, and the leg *C* has a slider having a head, which, in combination with the end of the leg *B*, is used as a caliper. The device is also useful as a measuring-rule.

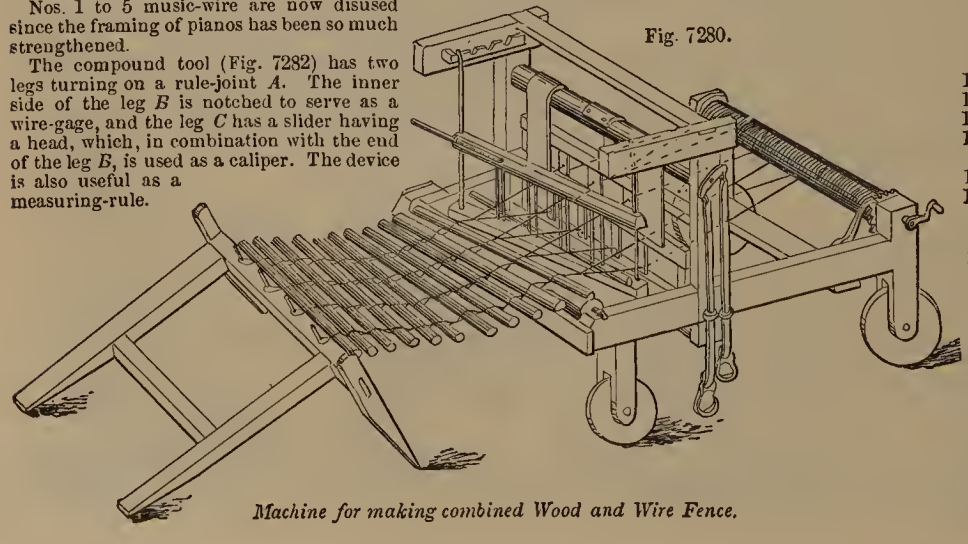


Fig. 7280.

*Machine for making combined Wood and Wire Fence.*

**Wire-gauze.** A fine, close quality in wire-cloth.

At the London Exposition of 1851, French specimens of wire-gauze were exhibited having 260 parallel threads to the linear inch, or 67,600 meshes to the square inch.

**Wire-guard.** A fire-guard of wire-cloth.

**Wire-mat'tress.** One having a web of wire-cloth or chain stretched in a frame for supporting a bed.

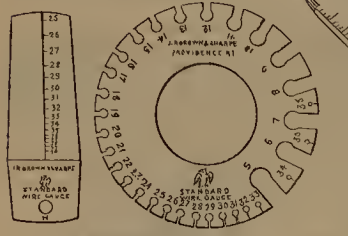
See patents: —

| No. | Date. |
|---|---|
| 139,077. | May 20, '73. |
| 144,564. | Nov. 11, '73. |
| 145,249. | Dec. 2, '73. |
| 133,533. | Dec. 3, '72. |
| 79,040. | June 16, '68. |
| 109,446. | Nov. 22, '70. |
| 132,175. | Oct. 15, '72. |

**Wire-mark'ing Ma-chine'.** A machine used in measuring and marking off lengths of wire for hoop-skirts. The endless band carries dies for marking the wire as it is fed from a spool. The band is

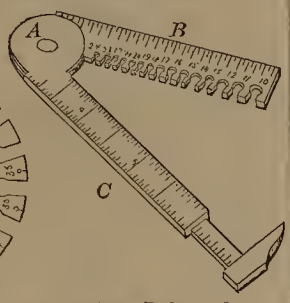
stretched over drums and under an ink-roller, and then passes between rollers, simultaneously with the wire to be marked.

Fig. 7281.



*American Wire and Screw Gage.*

Fig. 7282.




*Caliper, Rule, and Wire Gage.*

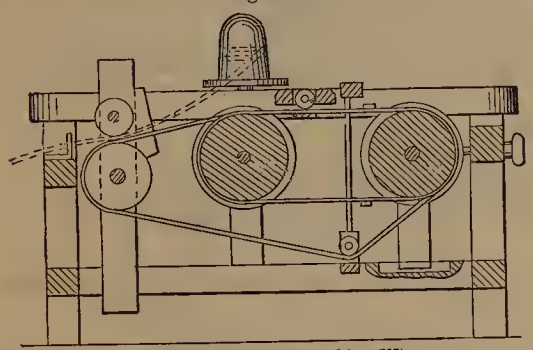
**Wire-mi-crom'e-ter.** A comparison of authorities shows that two other forms of micrometer were used before the wire-micrometer was introduced by Malvasia, about 1654.

These were the micrometer by Gascoigne, 1640, which consisted of nicely ground parallel edges of adjustable brass plates; and the slip of metal used by Huyghens, 1652. The latter was made to cover the image of the object in the focus of the lenses, and then compared with the breadth of the field. Hooke substituted parallel hairs for the parallel edges.

Malvasia constructed a micrometer having two parallel series of crossing silver wires, which divided the field of view into squares of equal size.

The *filar*, or *wire-micrometer*, has spider-lines, or fine wires, across the field of the instrument, and these are capable of being illuminated to assist observation. The wires are arranged in parallel and intersecting series, and some are capable of being moved by screws, so as to traverse the field of vision in a direction perpendicular to their length, so as to approach and recede from the others as measures of distance, the graduated heads of the adjusting screws noting the fractional parts of a turn.

Fig. 7283.



*Machine for making Skirt-Wire.*

The telescope of the mural circle, in the National Observatory, Washington, has at its focus a fixed diaphragm, having seven vertical wires and one horizontal wire. Another diaphragm, movable by a micrometer-screw, is furnished with five horizontal and equidistant wires, by which the distance of any star from the fixed horizontal wire is measured as it passes through the field. The intervals between the wire being previously accurately determined, the observation is conducted as follows: in whatever part of the field a star appears, a micrometer-wire is close at hand, and the star is bisected by the nearest wire, while the time at which it passes the several vertical wires is also noted. The number of the bisected wire and the reading of the micrometer being now entered, the observation is complete.

**Wire-nail.** A nail made from wire with a swaged head and point, or one forged in imitation thereof. Chests and boxes from the Continent of Europe and from Asia are found to be fastened with nails of this character. See NAIL.

**Wire-nail'ing Ma-chine'.** A machine for closing shoes with wire. See NAILING-MACHINE, pages 1507, 1508.

**Wire-net'ting Ma-chine'.** A machine for weaving wire-netting.

See patents: —

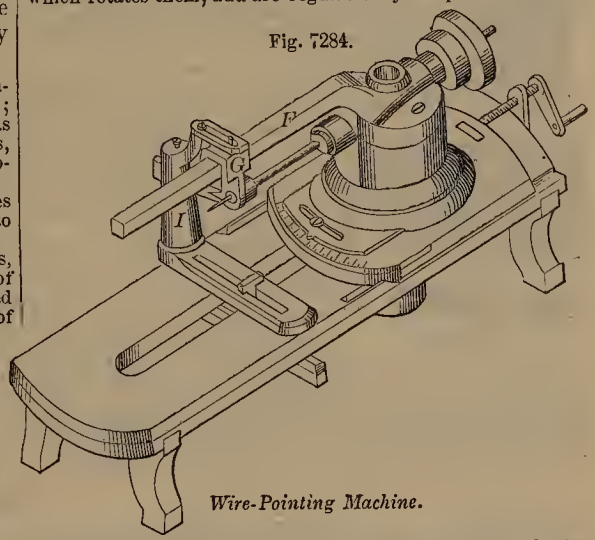
| | |
|---|---|
| 10,743. Nesmith, April 4, 1854. | 133,951. Powers, Dec. 17, 1872. |
| 121,831. Weber, Dec. 12, 1871. | |

**Wire-peg'ger.** A machine for fastening boot-soles with wire. Also called a wire-nailing machine. The kind of wire used is twisted so as to constitute it a screw, and is known as cable-screw wire. The thread gives it a better hold in the leather. See NAILING-MACHINE, Figs. 3283–3285.

**Wire-point'ing Ma-chine'.** The wire is slipped through the hollow mandrel of a lathe-head and secured. The end is presented to a stationary cutter in the overhang-rest *G*, which is supported upon the post *I*. The lathe-head is adjustable laterally to vary the angle of presentation and determine the taper of the point. A guide-arm *F* projects from the head and through a slot in the rest.

In Fig. 7285, the dies are arranged in the end of the shaft which rotates them, and are regulated by the points of conical screws which pass through them and into cavities in the bottom of the dovetail cross groove.

Fig. 7284.



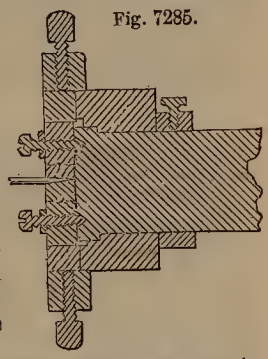

*Wire-Pointing Machine.*

See also patents: —

| No. | Name and Date. |
|---|---|
| 46,242. | Jillson, Feb. 7, '65. |
| 47,974. | Jillson, May 30, '65. |
| 58,730. | Manville, Oct. 9, '66. |
| 59,778. | Plumer, Nov. 20, '66. |
| 62,336. | Hopson *et al.*, Feb. 26, '67. |
| 63,270. | Lockwood, Mar. 26, '67. |
| 85,520. | Fowler, Jan. 5, '69. |
| 87,557. | Fowler, Mar. 9, '69. |

**Wire-road.** A wire suspended from posts, and serving as a track for transportation purposes. See WIRE-WAY.

Fig. 7285.



*Wire Pointing and Reducing Machine.*

**Wire-rope.** A collection of wires twisted or bound together, so as to act in unison in resisting a strain.

Wire-ropes were used in the Hartz mines in 1831, and there demonstrated their superiority to hempen ropes in situations where they are occasionally dragged through muddy water, rubbed upon rough surfaces, and exposed to constant friction upon pulleys.

Their introduction into England dates from about 1838. Mr. Telford, in his justly famous Menai suspension-bridge, used chains having long links.

Wire-rope has since superseded chain in the construction of suspension-bridges.

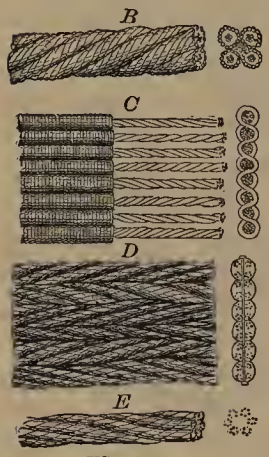
Its manufacture was commenced in Western Pennsylvania, by Mr. John A. Roebling, in 1837, and it was first introduced upon the inclined planes of the Portage Railway, over which the boats of the Pennsylvania Canal, divided into sections,

were transported across the Alleghanies. The roads of the Delaware and Hudson Canal Company and of the Pennsylvania Coal Company soon adopted them, and heavier ropes of 2 to 2½ inches diameter were then introduced upon the inclined planes of the Morris and Essex Canal in New Jersey. See INCLINED PLANE.

The earliest form of wire-rope was the *selvagee* rope, consisting of a number of wires laid together parallel, and secured by fine wire wound spirally around the whole. This was covered by woolen list, wrapped around in the contrary direction, and protected by a *service* of tarred rope-yarns, wound in the same direction as the covering wire.

This was succeeded by the plan of twisting soft annealed wire-strands, several of which were afterward laid up together, as in ordinary hempen ropes. It is inferior in strength to the selvagee rope, but more pliable, and readily admits of being spliced (*B*, Fig. 7286).

Fig. 7286.




*Wire-Ropes.*

About the same time flat wire-rope (*C*), composed of several strands having alternately a right and a left hand twist, was introduced; these strands were at first woven together with rope-yarn, but subsequently wire, passed in zigzag lines between the different strands, was employed (*D*).

At a somewhat later period *laid* rope (*E*) came into use; it is composed of strands of untwisted hard wire laid spirally around a central core of hemp or wire; a number of these strands, without any additional twist being placed aronnd a hempen core, form the rope.

It is stronger than either of the preceding kinds, and is now generally employed.

For making wire-rope the very best iron is selected, and the bars are drawn down at a welding heat to wire about ¼ of an inch in diameter. This is then cleaned in warm water acidulated with a little oil of vitriol, and being coated with a paste of rye flour, it is drawn through a succession of holes in a wire plate until it is reduced to the thickness of No. 5, when it is annealed by heating from five to eight hours, and is then cleaned and drawn down again until it is of the required degree of fineness. In general, ropes are made of strands, each of which has 3, 7, or 19 wires, the ropes having either 9, 49, or 188 wires.

A number of machines have been contrived for making wire-rope. Smith's (Fig. 7287) has been extensively employed for forming the strands by which submarine telegraph-cables are protected.

It consists of a number of disks *a a a* united by longitudinal rods, and rotated by speed-pulleys. In the axes of these disks frames carrying bobbins *b b b* containing the wire are centered, but are prevented by weights *c* from turning therewith. The wires from six of the bobbins are conducted through central openings in the disks *a a a*, and pass through the plate *d*, and over the *laying-top* *e*, the seventh wire serving as a core. After passing between the rollers *f*, and around the horizontal wheel *g*, the strand is conducted backward and wound upon the reels *h h*, the tension being regulated by a friction-brake *i*.

The strands are laid up into ropes by a similar machine.

In Fig. 7288, the spool-frames *C C'* are arranged between disks *B B' B''* on the hollow shaft *A*. The spool-frames have a universal joint at one end to enable them to be readily lifted to receive the spools *D*, and at the other end are rods *b' b'*, *c c'*, having cranked ends inserted into apertures in the disk *E*, through which an eccentric on the shaft *A* passes. A rotary motion is thus imparted to the spool-frames as the wires are withdrawn from the spools, and, passing through a fixed perforated block, are laid together to form the rope.

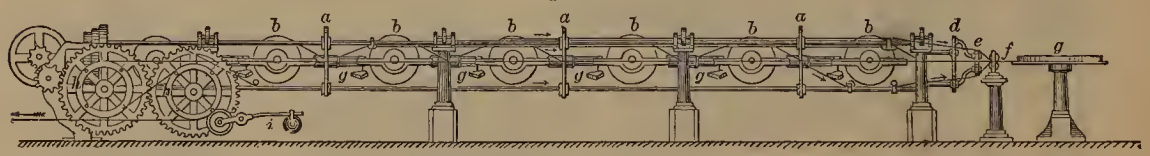
Wire-rope is made either with a wire or a hempen core. The latter is the more pliable, and will wear better where there is short bending. The larger sizes made at Roebling's, as also the more pliable, used for hoisting or running rope, are composed of 133 wires. Stiffer ropes, for guys or standing rigging, have 49 wires. These are only $\frac{1}{8}$ the bulk and $\frac{1}{2}$ the weight of hempen ropes of the same strength, and when used for shrouds and stays lighten the top hamper by that much, while affording less resistance to the wind.

When not galvanized, the wire is preserved by coating it with raw linseed-oil, applied with the hair side of a piece of undressed sheepskin, or by applying a paint of equal parts lampblack and Spanish brown, or Venetian red, mixed with linseed-oil.

It is protected under ground by saturation with a composition of one bushel fresh-slaked lime to one barrel mineral or vegetable tar, applied while boiling.

Wire-rope, for standing rigging, generally consists of six *strands* laid or spun round a hempen core, each *strand* consisting of six *wires*, laid the contrary way round a smaller hempen

Fig. 7287.




*Smith's Wire-Rope Machine.*

core. The spinning mechanism is so contrived that neither the *wires* nor *strands* are twisted.

Other wire-ropes are made of three strands of three wires each.

Barbarin, December 10, 1867, solders the ends of wire-ropes to prevent unwinding.

The longest and heaviest wire-rope probably in existence was made by Messrs. J. & E. Wright of Birmingham, England. It consists of six strands, containing each ten wires, surrounding a central core of hemp. Its length is 11,000 yards, and weight upward of 60 tons.

Other ropes, 5,000 to 6,000 yards long, weighing from 25 to 34 tons, have been made by the same firm.

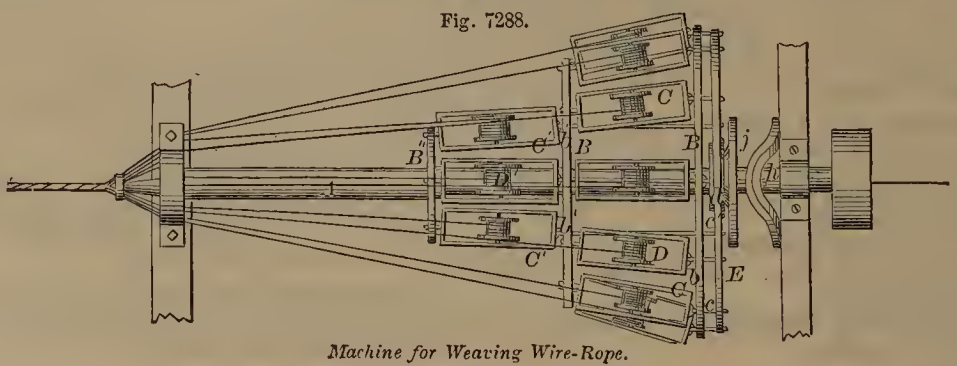
These, of course, bear no proportion in weight or length to some submarine telegraph-cables. The latter, however, are not made in one unbroken length.

Wire-ropes are used in the transmission of power from one locality to another, when the distance to be traveled is such as to render belting unsuitable.

At Frankfort-on-the-Main, the power of a 100 horse-power turbine is transferred 3,200 feet, to a cottou factory which is posted in a convenient position. Wheels 13½ feet in diameter are used, making 114 revolutions per minute. A §-inch wire-rope is used; stations 400 feet apart.

A series of powder-mills, embracing the various sbops where the compounding, grinding, sifting, glazing, etc., are carried on, are arranged in a series around the circumference of a circle of 1,200 feet radius, the machinery being driven by wire-ropes from a water-wheel in the center of the circle. The buildings are isolated by traverses, and have the benefit of the detached situatiou without the necessity for separate motive-powers.

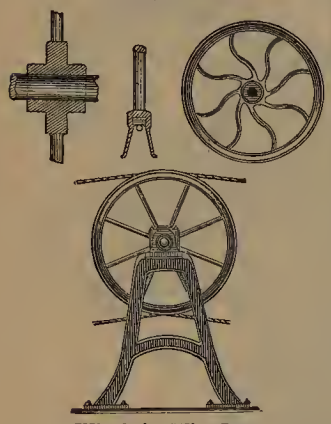
Fig. 7288.




*Machine for Weaving Wire-Rope.*

At the falls of the Rhine, near Schaffhausen, in Switzerland, a number of turbines are placed, having an aggregate horse-power of 600 horses. This is transmitted diagonally across the river to the town, which is about a mile lower down, and then distributed; advantage being taken of certain rocks in the river as foundations for the piers, which form the stations for the carrying-rollers.

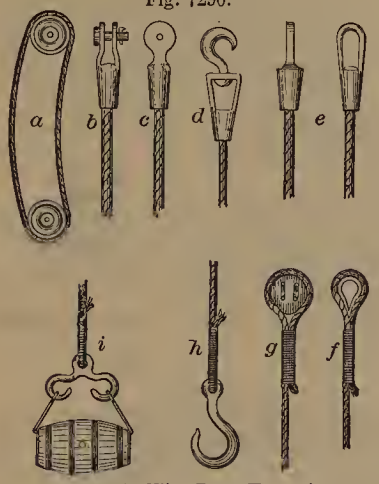
Fig. 7289.



*Wheel for Wire-Ropes.*

Fig. 7289 shows wheels and details of wheels employed in transmitting power by means of wire-rope. They are made of cast-iron, and the rims have one or more grooves adapted to receive and retain a packing on which the rope runs, to protect it from wear. A variety of materials are used for this purpose, as soft wood, leather, old tarred rope, oakum, and india-rubber, the latter material being preferable. It is cut into short pieces, having a section corresponding to, but slightly larger than, that of the groove into which the pieces are forced, so that they will not fly out. If leather be used, it is cut into thin strips, which are set on edge, several thousand being required for a large wheel. Tarred oakum is driven in by wedging: and ratline stuff or jute yarn, tarred, may be wound into the groove, soon becoming compacted by use.

Fig. 7290.

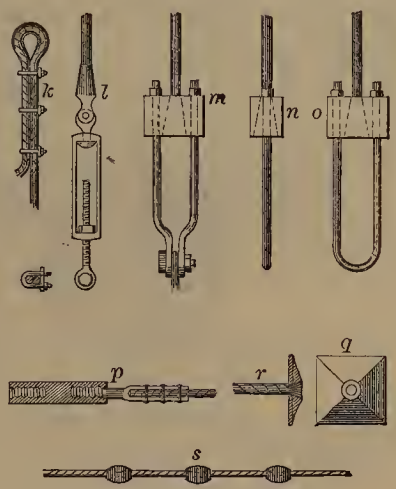



*Roebling's Wire-Rope Fastenings.*

Figs. 7290, 7291, illustrate Roebling's wire-rope fastenings:—

*a*, endless splice, for belt-ropes, etc.
*b c*, open socket, with pin; side and end views.
*d*, swivel-hook.
*e*, closed socket.
*f*, eye.
*g*, dead-eye.
*h*, eye, with hook.
*i*, eye with sister hooks.
*k*, thimble and clamps.
*l*, turn-buckle.
*m*, open stirrup.
*n o*, cast-iron socket with closed stirrup.
*p*, fastening for oil-well tools.
*q r*, plate fastening; plan and section.
*s*, hand-rope, with lugs.

Fig. 7291.




*Roebling's Wire-Rope Fastenings.*

TABLE OF WIRE-ROPE (ROEBLING).

| Rope of 133 wires. | | | | Rope of 49 wires. | | | |
|---|---|---|---|---|---|---|---|
| Trade Number. | Circumference in inches. | Ultimate strength in tons of 2,000 lbs. | Circumference of hemp rope of equivalent strength in inches. | Trade number. | Circumference in inches. | Ultimate strength in tons of 2,000 lbs. | Circumference of hemp rope of equivalent strength in inches. |
| 1 | 6¾ | 74.00 | 15½ | 11 | 4⅝ | 36.00 | 10¾ |
| 2 | 6 | 65.00 | 14½ | 12 | 4¼ | 30.00 | 10 |
| 3 | 5½ | 54.00 | 13 | 13 | 3¾ | 25.00 | 9½ |
| 4 | 5 | 43.60 | 12 | 14 | 3⅜ | 20.00 | 8¼ |
| 5 | 4⅜ | 35.00 | 10¾ | 15 | 3 | 16 00 | 7¼ |
| 6 | 4 | 27.20 | 9½ | 16 | 2⅝ | 12.30 | 6¼ |
| 7 | 3½ | 20.20 | 8 | 17 | 2⅜ | 8.80 | 5½ |
| 8 | 3⅛ | 16.00 | 7 | 18 | 2⅛ | 7.60 | 5 |
| 9 | 2¾ | 11.40 | 6 | 19 | 1⅞ | 5.80 | 4¾ |
| 10 | 2½ | 8.64 | 5 | 20 | 1⅝ | 4 09 | 4 |
| 10¼ | 2 | 5.13 | 4½ | 21 | 1⅜ | 2.83 | 3¼ |
| 10½ | 1⅝ | 4.27 | 4 | 22 | 1¼ | 2.13 | 2¾ |
| 10¾ | 1½ | 3.48 | 3¾ | 23 | 1⅛ | 1.65 | 2½ |
| | | | | 24 | 1 | 1.38 | 2¼ |
| | | | | 25 | ⅞ | 1.03 | 2 |
| | | | | 26 | ¾ | 0.81 | 1¾ |
| | | | | 27 | ⅝ | 0 56 | 1½ |
| | | | | 27½ | ½ | .... | .. |
| | | | | 28 | .. | large sash-cord. | |
| | | | | 29 | .. | small sash-cord. | |

**Wire-rope Railway.** Fig. 7292 illustrates Halladie's wire-rope traction-railway

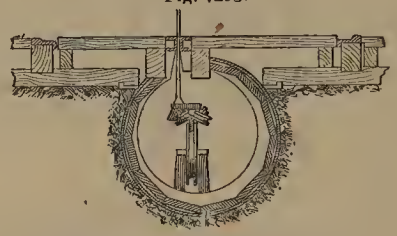
Fig. 7292.

*Wire-Rope Railway.*

system used by the Clay Street Hill Railway Company of San Francisco, Cal., on grades as steep as 850 feet.

The cars are drawn by an endless wire-rope placed in a tube below the surface of the ground, between the tracks, and kept

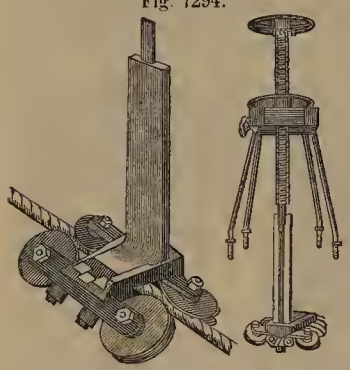
Fig. 7293.



*Sheaves for Wire-Rope Railway.*

in position by means of sheaves. A stationary engine is used as the motor, and acts on the rope by means of grip-pulleys. The rope is connected with the cars by a gripping attachment passing through a narrow slot in the upper side of the tube. The rope is supported at intervals of 39 feet and at the turnings by large sheaves, as shown in Fig. 7293.

Fig. 7294.



*Gripping-Attachment for Wire-Rope Railway.*

Fig. 7294 shows the gripping-attachment. It is provided with guide-sheaves and gripping-jaws, operated by the movement of a hand-wheel and screw; the jaws are clamped to the rope when the cars are set in motion. In stopping them, the jaws are released, and the sheaves then come in contact with the rope, but serve merely as guides. To return, the car or dummy-engine is transferred by means of a turn-table to another track, under which the rope moves in a reverse direction. See also WIRE-WAY.

**Wire-spring.** Coiled wire-springs are used for many purposes: in spring-balances; chronometer-balances; for upholstering cushions, chair and sofa backs, mattresses; and in many other places where but a moderate power is required.

It is customary to coil the wire upon a *former* of the required shape, cylindrical or conical, as in Fig. 7295, in which the wire passes from the coil on a detachable shaft and through an adjustable friction-guide to a spirally grooved former rotated by a winch.

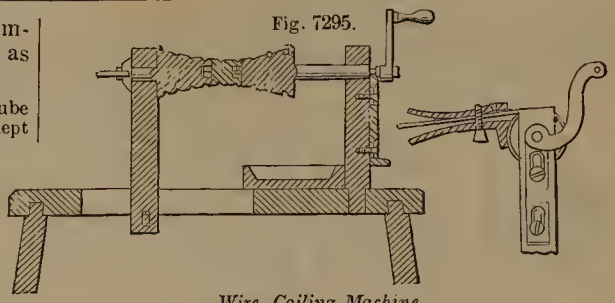
In Fig. 7296, the stationary inclined guide nearly encircles the mandrel upon which the spring is wound, to give the required pitch; two or more forming-wheels bend the spring around the mandrel.

In Fig. 7297, the joint of the wire is confined in the bisected tubular socket, and, commencing at the point, the wire is wound upon the conoidal, grooved former.

See following patents: —

| No. | Name and Date. |
|---|---|
| 14,566. | Lent, April 1, '56. |
| 16,483. | Harrison, Jan. 27, '57. |
| 16,916. | Gardiner, Mar. 31, '57. |
| 21,635. | Young, Sept. 28, '58. |
| 23,142. | Jenkinson, March 1, '59. |
| 24,259. | Young, May 31, '59. |
| 24,557. | Harrison, June 28, '59. |
| 32,395. | Young, May 21, '61. |
| 50,420. | Kellogg, Oct. 10, '65. |
| 50,622. | Payne, Oct. 24, '65. |
| 58,156. | Vose *et al.*, Sep. 18, '66. |
| 59,145. | White, Oct. 23, '66. |
| 63,445. | Weaver, April 2, '67. |
| 69,421. | Evans, Feb. 16, '67. |
| 70,770. | Woods *et al.*, Nov. 12, '67. |
| 74,233. | Manuel, Feb. 11, '68. |
| 88,031. | Goodale, Mar. 23, '69. |
| 112,526. | Allen *et al.*, Mar. 14, '71. |
| 112,868. | Van Fleek, Mar. 28, '71. |

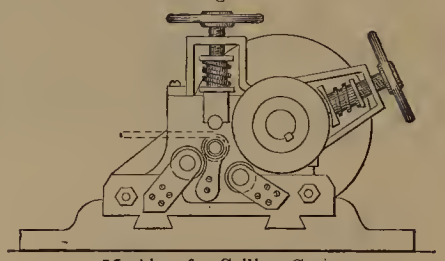
Fig. 7295.



*Wire-Coiling Machine.*

| No. | Name and Date. |
|---|---|
| 113,099. | Russell, Mar. 28, '71. |
| 115,413. | Baggott, May 20, '71. |
| 122,523. | Rhinelander *et al.*, Jan. 9, '72. |
| 126,315. | Mayall, April 30, '72. |
| 136,473. | Ward, Mar. 4, '73. |
| 152,557. | Haskall *et al.*, June 30, '74. |
| 153,387. | Smith, July 21, '74. |
| 153,388. | Smith, July 21, '74. |
| 154,563. | Powers, Sept. 1, '74. |

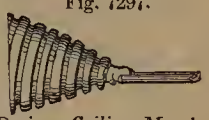
Fig. 7296.



*Machine for Coiling Springs.*

**Wire-spring Coil'ing-ma-chine'.** A machine for forming spiral springs from strips of metal.

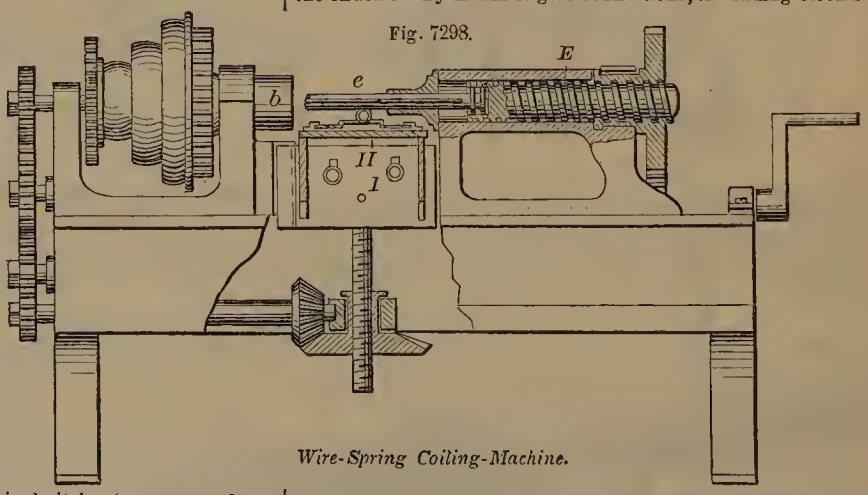
Fig. 7297.



*Spring-Coiling Mandrel.*

In Fig. 7298, the heated strip of metal is held by a guide-rest *H*, and its end inserted in a slot in the mandrel *e*, which turns loosely in the screw *E*. The mandrel is rotated by being brought into connection with the chuck *b*. By means of gear connections, the sliding-block *I*

Fig. 7298.




*Wire-Spring Coiling-Machine.*

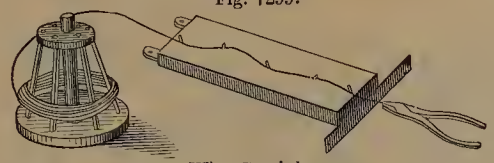
supporting the guide-rest is automatically lowered as the spring is coiled on the spindle, and the screw and mandrel are retracted by means of a hand-lever and gears.

**Wire-straight'en-ing.** Wire, being generally drawn upon reels, is met with in spiral coils, and, for most purposes, requires to be straightened before being used.

In the case of soft or annealed wire this is usually done by fixing one end and pulling the other with a pair of pliers; short pieces may be straightened by rolling them between two boards. The soft steel wire used for making needles is cut into lengths of four or five inches, and arranged in bundles within iron hoops four inches in diameter, and then rolled to and fro beneath a bar of iron about two feet long and narrow enough to lie between the rings.

Hard and unannealed wires are too elastic to yield to the above

Fig. 7299.



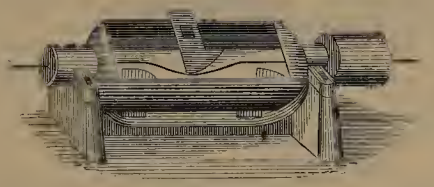
*Wire-Straightener.*

methods, and for straightening or *taking the spring out* of them, the *riddle* (Fig. 7299) is used.

This is a piece of wood or metal with sloping pins, which lean alternately opposite ways, so as to keep the wire close down on the board, and compel it to pursue a slightly serpentine course, which is considerably exaggerated; five pins are commonly used, but sometimes seven or nine.

In practice, the riddle is made wide enough to contain several

Fig. 7300.

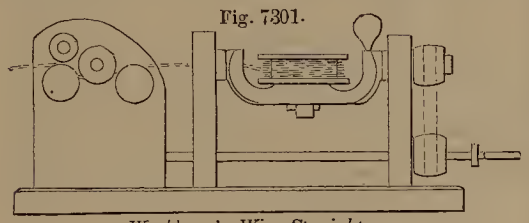


*Wire-Straightener.*

rows of pins, suitable for as many different sizes of wire as each wire requires a different set of pins. Between the pins of each set, and fixed down close to the board, is a straight metallic wire, about three times the diameter of the wire to be straightened, serving as a bed for the latter to run on.

The board is held in place by two staples at one end, which fit loosely over studs or nails in the work-bench.

Fig. 7301.



*Washburn's Wire-Straightener.*

The wire is drawn between the edges of two fixed pieces and an adjustable piece, by which the bends are straightened out.

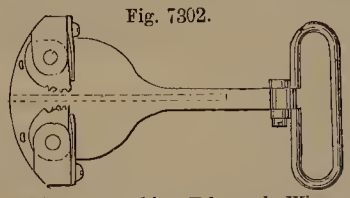
In Washburn's wire-straightener, July 4, 1865, a double-elbowed shaft, supported horizontally in suitable framework, carries within the elbow a reel supported by and turning upon a short journal, which projects from and at a right angle to the central horizontal portion of said elbow. The wire, first wound upon the reel, is thence passed through an orifice made through and coincident with the axis of one of the journals of the elbowed shaft, and thence to a series of small rollers suitably arranged for straightening the wire as they draw it gradually from the reel. In practice, the elbowed shaft is made to revolve with considerable velocity, and as the reel is carried around with it, the torsion thus produced keeps the wire perpetually turning over, thus offering successively every portion of its surface to the proper action of the straightening rolls.

See also patents No. 149,666, Mallett, April 14, 1874.
152,987, Greenwood, July 14, 1874.

**Wire-stretch'er.** A tool for straining lightly telegraph or fence wires.

The instrument is applied by moving it forward upon and against the wire, so as to force the jaws open to receive it; then on pulling the instrument it grasps the wire tightly.

Fig. 7302.



*Tool for Stretching Telegraph-Wires.*

**Wire-tem'per-ing Ap'pa-ra'tus.** A machine for giving the required degree of hardness to steel-wire.

It is passed at a proper speed through the apparatus. *A* is the heating-furnace containing a muffle, formed of an iron tube, coated externally and internally with graphite and clay, and closed at its ends by plugs of graphite or asbestus through which the wire passes. The wire next passes through a cylinder *c*, containing a bath of oil kept at a regulated temperature by a water-jacket; next it passes over a bed of charcoal which draws the temper. The wire is kept stretched by gripping-rollers.

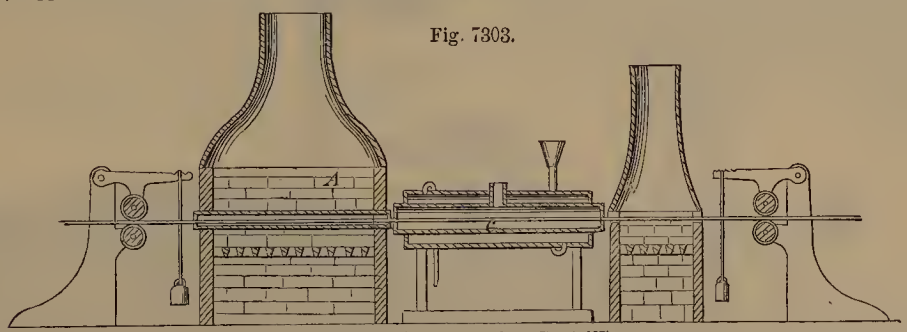
Fig. 7304 is an apparatus in which the object is to save space, and to bring both the discharging and receiving drums under care of one operator. The wire passes through the melted metal, and then, after passing through the oil-tank, turns around a roller and returns through the tempering-tank.

Patent No. 65,699 uses gas-jets.

**Wire-tram'way.** A mode of conveyance by or upon a wire supported on posts. See WIRE-WAY.

**Wire-twist.** A kind of gun-barrel made of a ribbon of iron and steel, coiled around a mandrel and welded. The ribbon is made by welding to-

Fig. 7303.



*Apparatus for Tempering Steel-Wire.*

gether laminæ of iron and steel or two qualities of iron, and drawing the same between rollers into a ribbon.

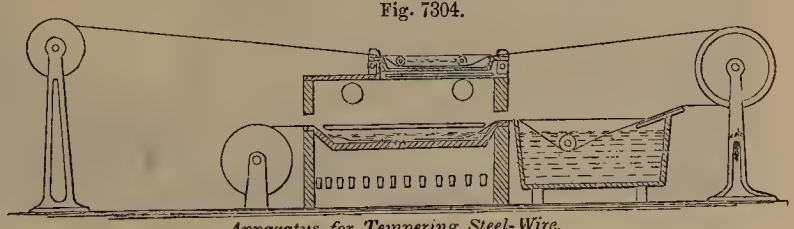
**Wire-twist'ing Ma-chine'.** A tool used for uniting the ends of sections of telegraph or fencing wire, and for other purposes.

See patents: —

40,586. Dimock, Nov. 10, 1862 (tags).
122,903. Murray, Jan. 23, 1872 (fire-screens).
130,778. Wolcott, Aug. 20, 1872 (telegraph).
145,994. Fry, Dec. 23, 1873 (telegraph).

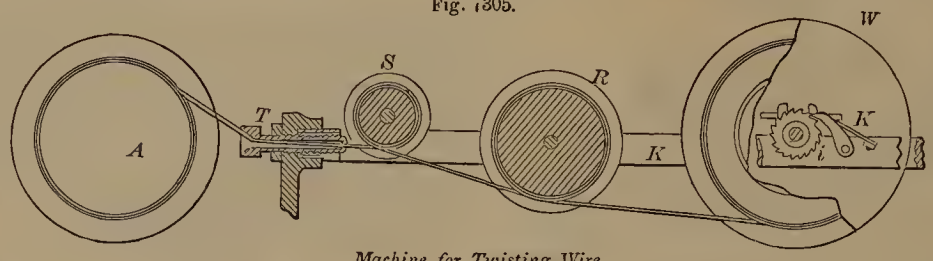
Smith's machine, for making cable-screw wire, is shown in Fig. 7305. The wire is polygonal in form, is wound from a drum *A*, passes through a die *T* to a winding-drum *W*, which by the

Fig. 7304.



*Apparatus for Tempering Steel-Wire.*

Fig. 7305.




*Machine for Twisting Wire.*

action of a spring keeps it at the proper tension, and winds it as fast as twisted. One wheel *S* guides it through the die, and another *R* draws it; the revolution of the frame *K* is constant and gives the twist. The variation in the twist is given by the rate of drawing.

In Shortan's machine the band or wire is stretched the length of the machine, being held in the slotted standards and their intervening slotted pinions. The latter being revolved by the sector-wheels, which are oscillated by a treadle, the revolution of the pinions twists the wire.

**Wire-way.** A wire or wire-rope suspended from posts, and forming a way upon which loaded carriages traverse for the conveyance of freight.

This mode of transportation was described and represented in a work written by Mandey and Moxon, and published in London in 1696.

Hodgson's wire-tramway, lately introduced into England, is substantially similar to the elevated railways which were patented in England in 1825 by Palmer, Fisher, and Dick. See ELEVATED RAILWAY.

An endless wire-rope is carried on a series of grooved pulleys, supported in pairs upon stout posts ordinarily about fifty yards, but in some cases at much farther intervals apart. At one end the rope passes around a clip drum, worked by a stationary engine; at the other end it passes around a plain cylinder.

In one erected in Leicestershire, for conveying stone from the quarry to a railway station, a distance of three miles, the rope, ½ inch in diameter, is driven at the rate of four miles an hour by a 16 horse-power engine working with ten pounds of steam; this may be increased to five or six miles an hour. The boxes or carriages are about two feet long, one foot to eighteen inches wide, and six inches deep, their ordinary load being one cwt. They are not clamped to the rope, but adhere to it by friction; an upright stanchion on each side is bent over at top, and the two ends are connected by a block of wood which is hollowed out beneath so as to fit the rope, and pass over the suspension pulleys. The hourly delivery of stone at the station is ten tons, and the empty boxes are returned at the same rate as the full ones are delivered. Where the amount of freight to be accommodated is large, it is proposed to use a stout fixed rope to support the carriages and a lighter traveling rope to pull them.

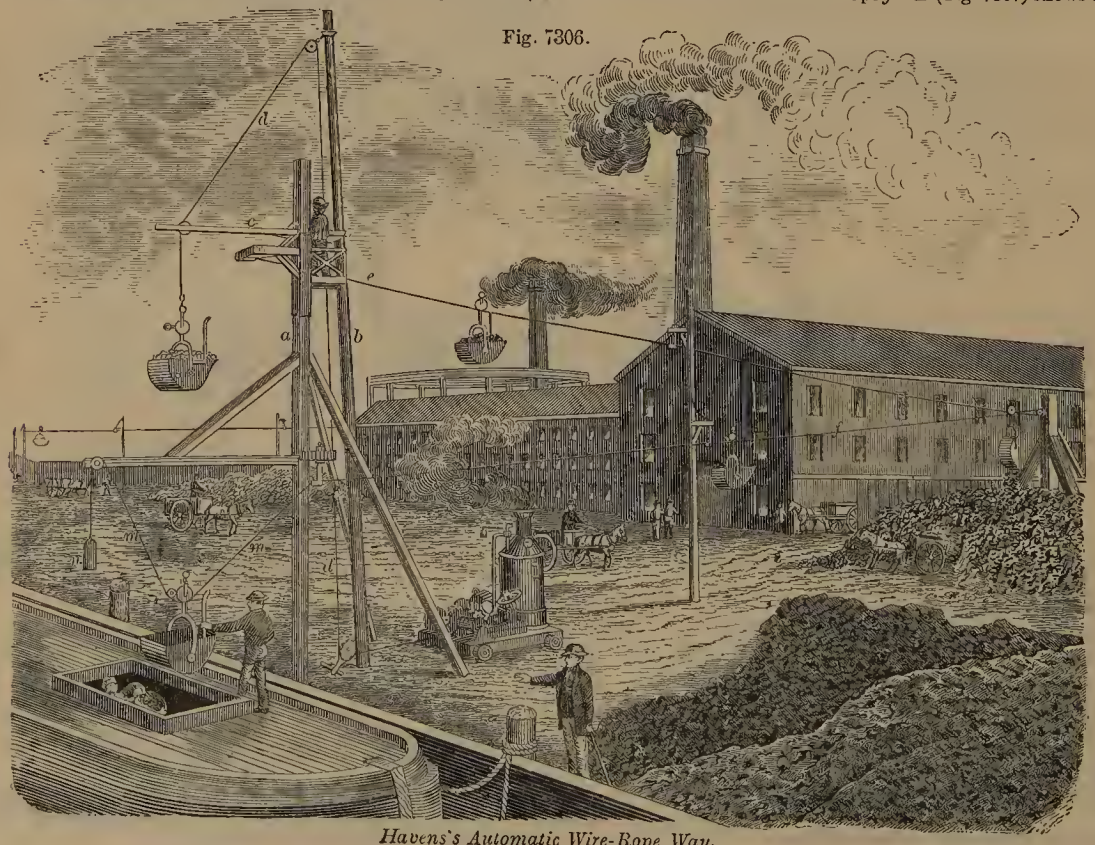
An elevated tramway at Brighton, England, on the Hodgson plan, is five miles long, and is capable of carrying each way one hundred and twenty tons per day of ten hours, two hundred and forty tons in all. When working to its full capacity both ways the loads on the opposite wires tend to counterpoise each other, and the expenditure of power is reduced to a minimum.

Various other plans on the same general principle, but differing in detail, are in operation in various parts of the world. In some the rope supporting the carriages is movable, and in others it is stationary, the carriages being drawn by an auxiliary rope.

Havens's automatic wire-rope railway (Fig. 7306) is particularly designed for loading and unloading vessels, or conveying freight from one point to another in the same vicinity. The rope is stationary, and the movement of the carriage is effected by its own gravity.

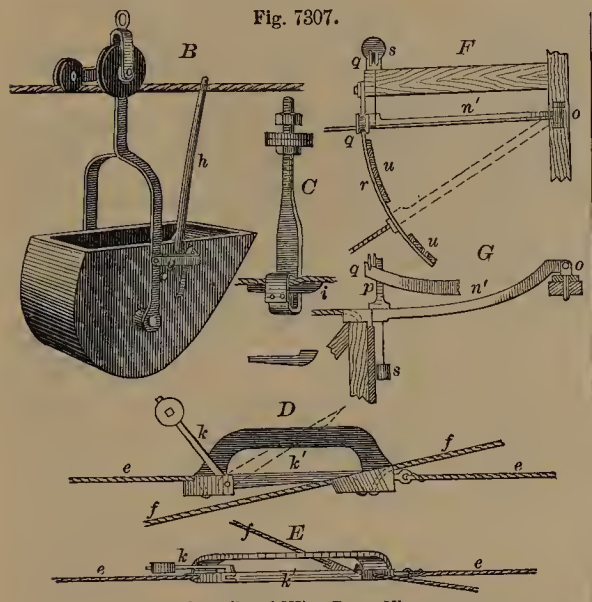
Fig. 7306 illustrates the apparatus at work discharging coal from a barge. Two tall poles *a b* are erected near the wharf. The first has a hinged outrigger *c* which can move only in a vertical plane. The loaded bucket is hooked on to the fall *d*, and run up by the hoisting-engine until a knot in the rope strikes the outrigger, which is then lifted with the bucket until it becomes vertical, and the bucket is brought directly over the rope *e*. The fall is then slacked, and an attendant on the elevated platform guides the rollers of the bucket directly on to the rope, along which it descends until arriving at the point of discharge, where the load is automatically dumped and the bucket transferred to the return rope *f*. *B* (Fig. 7307) shows the

Fig. 7306.




*Havens's Automatic Wire-Rope Way.*

Fig. 7307.




*Details of Wire-Rope Way.*

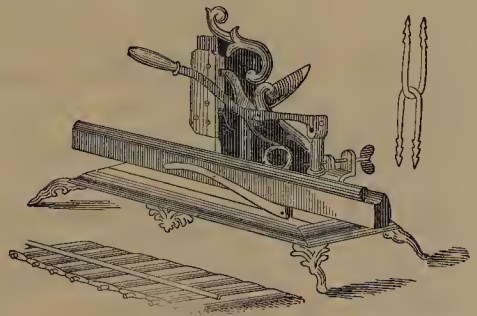
bucket, which is suspended from a larger and smaller connected pulley by an upright bar extending upward from the bail. At the side of the bail is a slotted piece *g*, slipping over an upwardly projecting stud, and holding the bucket horizontal; to this is attached a rod *h*, which, when the bucket arrives at its destination, is arrested by a stop disengaging the catch, and allowing the bucket to tilt and discharge its contents. The supports, which prevent the rope from sagging and at the same time permit the buckets to pass freely along the line, are shown at *C*. These depend from arms attached to the posts, and in them the rope is held fast by keys *i*.

After discharging, the buckets are transferred to the return-rope *f*, by the device shown in elevation at *D* and in plan at *E*. The tongue *k'* of the bent lever *k* is ordinarily held in the raised position shown by the dotted lines, but when struck by the pulleys as the bucket passes it is depressed and the bucket runs along it, and some distance up the rope *f*, until its momentum is checked and it commences its return movement; it then proceeds along *f* to the place of loading, and on passing the last suspending pulley, dependent from the post *b*, runs upon the rope *m* having a weight *n* attached, and, raising the weight, descends by its own gravity into the vessel's hold to be reloaded.

*F G* are respectively a plan and elevation of a switch, by which the buckets may at any point of their course he turned off and directed on to another line of rope. *n'* is a curved metallic arm connected by a double pivot *o* to a support, so as to have both transverse and vertical motion; at the opposite end is a standard *p*, on top of which is a small roller *q*, and which is lifted hy an attached cord and weight *s*.

Fastened to the framework of the device is a track *r*, on which the roller *q* runs, and which bends downwardly hetween its two supports. While the arm *n* is drawn up by the weight *s* it remains at the highest point of the track *r*, and in line with the upper rope, but when a bucket arrives and slides upon the

Fig. 7308.



*Blind-Wiring Machine.*

arm *n'*, its gravity causes the arm to descend until it is arrested at a point directly opposite to the end of the rope *f'*, to which the bucket is to be transferred; stops *u u* along the track prevent the bucket running off the arm, until it is brought into the correct position.

**Wire-wheel.** A brush-wheel made of wire, iron, or brass, instead of bristles, used for cleaning and scratching metals, preparatory to gilding or silvering. Also used in *matting* polished metallic surfaces.

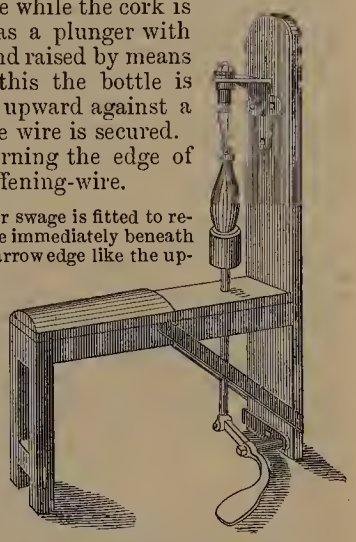
**Wir'ing-ma-chine'.** 1. A machine for driving the staples connecting the slats to a Venetian blind, and for wiring the slats to the rod which turns them.

That illustrated is attached to a bench and operated by hand; others have an independent stand and are worked by a treadle. The devices embrace guides for directing the staples; a feeder for inserting them between the guides; a driver, and a device for moving the rod forward any required distance as each staple is driven; the whole being operated by the hand-lever or treadle. See also Figs. 719, 720.

2. An apparatus for securing a soda-water or other bottle while the cork is being wired. It has a plunger with an enlarged head, and raised by means of a treadle. On this the bottle is placed, and pressed upward against a fixed piece while the wire is secured.

3. A machine turning the edge of a tin-pan over a stiffening-wire.

Fig. 7309.



*Cork-Wiring Machine.*

A square roller, die, or swage is fitted to revolve in a suitable frame immediately beneath a round roller with a narrow edge like the upper roller of a common wiring-machine.

**Wisp.** A besom. A small broom.

**Witch'et.** A kind of plane with a conical aperture and inclined knife, which reduces to roundness a bar which is rotated as it is passed therethrough.

See ROUNDING-PLANE; AUGER.

**Withe.** 1. A band or tie made of a twisted flexible sapling.

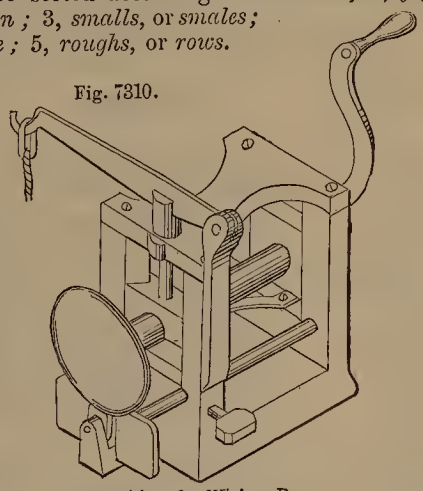
2. A flexible handle to a cold-chisel, setter, or fuller.

3. (*Nautical.*) A ring or boom-iron, by which a beam is set out or in on its principal spar.

4. (*Building.*) A wall dividing two flues in a stack of chimneys.

**Witts.** Tin ore from the stamping-floor. The earthy portions being removed by water, the clean *witts* are sorted according to size into, 1, *jigged;* 2, *flucan;* 3, *smalls*, or *smales;* 4, *slime;* 5, *roughs*, or *rows.*

Fig. 7310.



*Machine for Wiring Pans.*

**Wolf.** A *beating* or *opening* machine, for tearing apart the tussocks of cotton as delivered in the bale. It is a preliminary operation, by which dust and trash are rendered separable and the fiber delivered in a

more downy condition, so as to subsequently form a *lap*.

Also called a *devil*, *willower*, *twilly*, etc. See COTTON-CLEANING MACHINE.

**Wolf'ram.** Native tungstate of iron and manganese. *Mock-lead.*

## Wood.

In countries where the palm and bamboo grow, the smaller stems are used as tubes for the conveyance of water, and the larger stems for joists.

The hard fibers of the palm, which are embedded in the pithy substance of the trunk, are in some cases employed as nails. Small palms, under the name of partridge and Penang canes, are used as walking-sticks.

Some varieties are employed in cabinet and marquetry work, for billiard-cues, snuff-boxes, etc. The twisted palm walking-sticks are made of the central rib from the leaf of the date-palm, twisted while green and stretched.

The nuts of many species are also used in the arts. The betel or areca nut is made into necklaces, the tops of walking-sticks, and other small objects. The husk of the cocoa-nut yields coir, and its shell is made into cups, vases, and buttons. The hard coquilla-nut is turned into knobs, small toys, etc.

The cocoa-nut palm is of universal utility where grown, its fruit affording food, the husk coir of ropes, the leaves are made into baskets and mats, the stem is used for building purposes, and different parts of the tree are made to yield oil, sugar, palm wine, and arrack.

The exogenous woods are, however, of greater value for most economic purposes; in this regard they may be divided into several groups, either according to their physical character, as hard and soft, tough and brittle, or according to the appearance presented by their dressed surfaces, the grain.

Another classification adopted by Holtzapffel depends on the peculiar uses for which they are fitted, comprising building woods, used in ship and house carpentry and engineering; woods for machinery and mill work; turnery woods; furniture woods; ornamental woods; dye woods.

These divisions, of course, blend into one another to a certain extent.

At the principal entrance of an ancient Roman villa, near Pompeii, which had apparently been overwhelmed by the same eruption which nearly destroyed that city, A.D. 79, was found, in 1835, a large beam of squared wood, probably intended for the lintel of a door. It appeared completely charred, and emitted a strong odor of carbonic-acid gas. On being handled, the outer part crumbled into dust, but the center was sound, though black as jet.

After being exposed to the air for two years, to free it from its offensive smell, it was sawn, and two tables made from the wood. One of these was shown at the London Exhibition of 1851. The age of the wood, when cut, was estimated at two centuries, so that it would now be about 2,000 years old.

The densest known wood is the *iron-bark* wood of New South Wales, which has a specific gravity of 1.426; the lightest, the *Cortica*, or *Anona palustris*, from Brazil, having a specific gravity of only 0.206, being lighter than cork.

Woody fiber is considerably denser than water; the presence of air between the pores causes most kinds to float in water; but when thoroughly saturated they sink. Scoresby relates the case of a boat which was dragged down to a great depth by a whale, and on being raised to the surface sunk immediately, like lead, when released from the suspending-line.

Many woods owe their density to resin or gum, which fills their pores; this seems to act as a cement, and bind the fibers more firmly together; such woods are durable, as they are better protected from water and insects.

Warping and winding, in seasoning, arise from the curved direction of the fibers, and from their spiral arrangement in many trees; boxwood is often much twisted in this manner.

In straight-grained woods, as pine and mahogany, there is but little contraction; but in some of the ornamental kinds, having great confusion of fibers, the shrinkage is so irregular that much warping, and even cracking, result. In the more valuable woods, the thinness of the veneers into which they are cut remedies this evil, as permanence of form is secured by gluing them upon some firm, straight-grained wood.

Green wood contains from 38 to 45 per cent of water, the greater part of which is removed in the process of seasoning. This, when effected in the natural way, by mere exposure to the air, requires a long period of time — from eight to ten years — for large-sized oak timber. Unless great care be taken dry-rot is apt to set in; it is also liable to irregular contraction and splitting, particularly in the direction of the medullary rays. There is usually no material reduction in the length of the timber.

In teak this contraction is hardly perceptible, while in soft woods it may amount to ½ inch in the foot. The elasticity depends upon the straightness of the longitudinal fibers, freedom from knots, and the simple character of the medullary rays; the most elastic woods, as lance-wood and hickory, are easiest to split, while those in which the fibers are much interlaced, as lignum-vitæ and gnarled oak, are split with great difficulty. The interlacement of the fibers, while depriving wood of its elasticity, renders it tough, and gives to many species, when polished, a beautifully variegated appearance.

The flexibility of woods is much increased, for the time, by steaming; this is done in the case of ship-timber, shafts, staves, etc., which are bent in the direction of the grain: economy of material and strength are thus secured. Timber treated with steam, at a temperature of 482° Fah., has its fibers drawn closer together; maple and pine thus treated are rendered more valuable for musical instruments, as sound-boards, etc.; walnut becomes darker from the formation of a kind of tar, which tends to preserve it. The loss of weight is from one third to one half. Mechanical compression greatly increases the density of wood; this is practiced in the case of tree-nails, which are driven through metallic rings, smaller than themselves, into the ship's side (Annersly's patent, 1821), the fibrous structure remaining undisturbed.

Wood is subject to unsoundness. It may be

*Ring-hearted;* split in the direction of the rings of yearly growth.

*Shaky;* split in the direction of the medullary rays; that is, from the heart outward.

*Knotty;* defaced by large or loose knots.

*Doted;* decayed.

Lumber is depreciated in value by the above, and by

*Sap;* the *alburnum*, or sap-wood between the inner bark and the hard wood, or *duramen*.

*Waney* portions; where the edge is not square.

*Knots*, *burls*, *blisters*, and *bird's-eye* are irregularities of grain produced at the divarications of limbs, the healing over of wounds, and protuberances, from whatever cause, which twist or warp the grain from its straight course.

TABLE OF WOODS (*"Eastern U. S." means East of Rocky Mountains*).

| Name of Tree. | Botanical Name. | Native Place, or where chiefly grown. | Qualities, Uses, etc. |
|---|---|---|---|
| Acacia | Acacia proxima mordi.. | Warm climates.... | Hard, tough. Shipbuilding, gum, tanning. |
| Alder | Alnus glutinosa, etc..... | Europe, etc..... | Hard. Cogs, pumps, wooden shoes, spoons, turnery. |
| Almond | Amygdalus communis.. | South of Europe, Syria, Barbary | Hard. Tool-handles, cogs, pulleys, etc. |
| Amboine | ..... | W. coast of Africa.. | Fancy tables and boxes. |
| Apple | Pyrus malus..... | America & Europe | Medium. Turnery, ornamental cabinet-work, etc. |
| Apple (Am. crab).... | Pyrus coronaria..... | Eastern U. S. .... | Hard, light red. Turnery. |
| Arbor vitæ..... | Thuja occidentalis, etc.. | Temperate climes . | Soft. Carpentry, etc. |
| Ash | Fraxinus excelsior..... | Britain, etc..... | Hard, tough. Handles, turnery, hoops, machine-work. |
| Ash (black)..... | Fraxinus sambucifolia.. | Eastern U. S. .... | Hard, very lasting. Hoops, splints, etc. |
| Ash (blue) | Fraxinus quadrangulata | Eastern U. S. .... | Hard, white, lasting. Same as white or gray ash. |
| Ash (white)..... | Fraxinus americana.... | Eastern U. S. .... | Hard, white. Carpentry, agricult'l implements, wagons. |
| Bamboo | Bambusa arundinacea. | China, India, etc.. | Various. |
| Bar-wood..... | ..... | Africa ..... | Turning ramrods, violin-bows, dyeing. |
| Basswood..... | (See Linden.) | | |
| Beech..... | Fagus sylvatica..... | Temperate Europe..... | Hard. Handles, lasts, boot-trees, planes, pegs; stained for furniture. |
| Beech..... | Fagus ferruginea..... | Eastern U. S. .... | Hard, yellow. Framing planes, tool-handles, turnery. |
| Birch | Betula alba..... | Temperate Europe | Hard. Legs for tables, water-taps, butter-molds, spoons. |
| Birch (paper) ..... | Betula papyracea..... | N. E. America.... | Canoes. |
| Birch (white)..... | Betula alba populifolia.. | N. E. America.... | Furniture. |
| Birch (yellow)..... | Betula lutea..... | N. E. America.... | Furniture. |
| Biti..... | ..... | India ..... | Open-grained; resembling rosewood in color. |

| Name of Tree. | Botanical Name. | Native Place, or where chiefly grown. | Qualities, Uses, etc. |
|---|---|---|---|
| Black Botany Bay wood | ..... | Australia, etc..... | Hard. Handles for instruments, turning. |
| Blue gum ..... | Eucalyptus globulus.... | Australia ..... | Hard. House and ship building, bridges, piles. |
| Bog-oak..... | Quercus (?) ..... | Eng. and Ireland.. | Hard and black. Fancy cabinet-work, inkstands, etc. |
| Boxwood ..... | Buxus sempervirens .. | S. and W. Europe and Asia Minor | Hard. Turnery, wood-engraver's blocks, rules, etc. |
| Brazil wood ..... | Cæsalpina ecbinata .... | Brazil..... | Dyeing, violin-bows, turning. |
| Buckeye..... | Æsculus glabra..... | Tennessee and northward .... | Soft, spongy, white. Splints for baskets, bowls. |
| Bullet-tree ..... | Achras sideroxylon .... | Jamaica..... | Hard, durable. Best timber-tree of Jamaica. |
| Buttonwood..... | (See Sycamore ) | | |
| Calamander ..... | Diospyros quæsita..... | Ceylon..... | Very hard; beautifully marked. Furniture. |
| Camphor-wood ..... | ..... | Warm climates ... | Soft. Cabinet-work and turuing. |
| Cam-wood ..... | ..... | Africa..... | Dyeing and turning. |
| Canary-wood ..... | ..... | Brazil..... | Cabinet-work, marquetry, turning. |
| Cangica-wood ..... | ..... | Brazil..... | Cabinet-work, turning. |
| Catalpa..... | Catalpa bignonoides .... | Eastern U. S. .... | White, lasting. Posts. |
| Cedar ..... | Cedrela australis..... | New S. Wales .... | Soft. Furniture and small cabinet-work. |
| Cedar (bastard)..... | Libacedrus decurrens .. | S. California. | |
| Cedar (red)..... | Juniperus virginiaua ... | East'n U. S. & Utah | Soft. Pencils, furniture, cigar-boxes. |
| Cedar (rock) (yellow cedar)..... | Juniperus californica... | Utah to Pacific ... | Yellow, lasting. Various. |
| Cedar (Spanish)..... | ..... | W. Ind , S. Am'ca | Cigar-boxes. |
| Cedar (Western)..... | Juniperus occidentalis.. | Utah to Oregon .. | Various. |
| Cedar (West Indian). | Cedrela odorata..... | W. Indies ..... | Soft. Furniture, small cabinet-work, cigar-boxes. |
| Cedar (white)..... | Cupressus thyoides..... | N. J. & southward | Building and fencing. |
| Cedar (white)..... | Thuya occidentalis..... | N. E. States..... | Various. |
| Cedar-wood ..... | Cedrus libani ..... | Lebanon. | |
| Cherry ..... | Prunus cerasus ..... | Europe ..... | Soft. Cabinet-work, turnery, Tunbridge-ware, etc. |
| Cherry (wild black).. | Prunus serotina..... | Eastern U. S. .... | Medium, red. Furniture. |
| Cherry-tree ..... | Exocarpus cupressiformis | Australasia..... | Hard. Gun-stocks, axe-handles, spokes, turnery, etc. |
| Chestnut..... | Castanea vesca..... | Am'ca and Europe | Takes a good polish. Furniture, turnery, hoops, etc. |
| Cocoa-wood ..... | ..... | W. Indies ..... | An exogenous hard wood used for turning and flutes. |
| Cogwood..... | Laurus chloroxylon.... | Jamaica..... | Hard. Mill-framing, cog-wheels, etc. |
| Coquilla-nut ..... | Attalea funifera..... | Brazil..... | Nuts, hard. Used in turnery. |
| Cork-oak ..... | Quercus suber..... | S. W. Europe .... | The bark affords common cork. |
| Cotton-wood ..... | Populus monilifera..... | W. States and Terr. | Medium, white. |
| Cowdi pine..... | Dammara australis..... | Temperate climes . | Wood very durable. Turnery, etc. |
| Cypress..... | Cupressis sempervirens . Cupressis thyoides..... | Southern U. S..... Florida, etc. | Soft. Carpentry, shingles, etc. |
| Cypress..... | Torreya taxifolia..... | New Zealand ..... | Hard. Shipbuilding, etc. |
| Deodar..... | Cedrus deodar ..... | Himalaya and India | Wood very durable. Building, etc. Yellow color. |
| Dogwood..... | Bedfordia salicina..... | Tasmania ..... | Hard; beautifully marked. Ornamental furniture. |
| Dogwood..... | Cornus florida..... | Eastern U. S. .... | Hard, red. Turnery. |
| Dogwood..... | Piscidia erythrina, etc.. | Jamaica..... | Hard. Wheels, carriages, etc. |
| Douglass pine ..... | Abies douglassii..... | Britain, etc..... | Medium. Carpentry, building, etc. |
| East India blackwood | Dalbergia latifolia..... | India ..... | Heavy, close-grained. Furniture. |
| Ebony..... | Diospyros ebenus ..... | Mauritius, Ceylon, India, Africa | Hard. Boxes, inkstands, furniture, etc. Black ebony. |
| Ebony (West Indian) | Brya ebenus..... | Jamaica ..... | Hard. Turnery, cabinet-work, etc. Green ebony. |
| Elder..... | Sambucus nigra..... | Europe and Am'ca | Soft. Turnery, rules, shuttles, sap-spiles. |
| Elm..... | Ulmus campestris, etc... | Europe..... | Hard, durable. Planking, wedges for railway chairs. |
| Elm (red) ..... | Ulmus fulva ..... | Eastern U. S. .... | Medium, red. Carpentry. Bark yields slippery elm. |
| Elm (white)..... | Ulmus americana..... | Eastern U. S. .... | Medium, white. Staves, hoops. |
| Fir (red silver) ..... | Abies amabilis ..... | Sierra Nevada .... | (See also Spruce ; Hemlock ) |
| Fir (Scotch)..... | Pinus sylvestris..... | Europe ..... | Medium hardness. The yellow *deal* used in Europe. |
| Fir (silver)..... | Abies grandis..... | California. | |
| Fustic ..... | Morus tinctoria..... | N. and S. America | Dyeing, mosaic-work, and turning. |
| Greenheart..... | Nectandra rodiæi ..... | Guiana, Triuidad . | Hard and very durable. Shipbuilding, wharves, bridges. |
| Gum (sour or black).. | Nyssa multiflora ..... | Eastern U. S. .... | Hard, tough, white. Hubs. |
| Gum (sweet or red).. | Liquidamber styraciflua | Eastern U. S. .... | Inferior to the black. |
| Hawthorn..... | Cratægus oxyacantha... | Europe, etc..... | Hard and white; takes a good polish. Turnery. |
| Hazel..... | Corylus avellana ..... | Europe..... | White; takes a good polish. Turnery, hoops, etc. |
| Hemlock (spruce).... | Abies canadensis..... | Northern America. | Various. |
| Hickory (Eastern shell-bark)..... | Carya alba ..... | East of Alleghanies | Hard. Implements and vehicles. |
| Hickory (Western shell-bark, etc.).. | Carya sulcata, etc. ..... | Mississippi Valley . | Hard. Implements and wagons. |
| Holly..... | Ilex aquifolium..... | Europe ..... | Hard. Turnery, cabinet-work, calico-printer's blocks. |
| Holly..... | Ilex opaca..... | S. E. United States | Hard, white. Ornamental. |
| Hoonsay ..... | ..... | India ..... | Alternate red and black streaks. |
| Hornbeam ..... | Carpiuus betulus..... | Europe ..... | Hard. Mill-work, turnery, etc. |
| Horse-chestnut..... | Æsculus hippocastana.. | Asia and Europe.. | Soft. Brush-backs, Tunbridge-ware, turning. |
| Huon pine..... | Dacrydium franklinii .. | Tasmania ..... | Hard. Planking, house, and ship buildiug, cabinet-work, picture-frames, etc. |
| Iron-wood ..... | Bumelia lycioides ..... | Eastern U. S. .... | Hard. Turnery. |
| Iron-wood (redwood). | Exythoxylon areolatum. | Jamaica ..... | Hard. Cog-wheels, mill-frames, etc. |
| Jack-wood ..... | Artocarpus integrifolia . | S. Asia, Ceylon ... | Hard. Furniture, etc. |
| Juniper..... | (See Cedar.) | | |
| Kiaboca-wood ..... | ..... | E. Indies ..... | Boxes and ornamental work. |
| King-wood ..... | ..... | Brazil ..... | Hard. Turning and small cabinet-work. |
| Laburnum ..... | Cistisus alpinus, etc.... | Europe ..... | Hard. Turnery, etc. |
| Lancewood..... | Anona duquetia ..... | S. America ..... | Hard. Springs, archery bows, cues, and fishing-rods. |
| Lancewood (black)... | Oxandra virgata ..... | Jamaica..... | Hard. Springs, archery bows, cues, and fishing-rods. |
| Larch..... | Larix europæa ..... | Europe ..... | Durable. Various uses; source of Venice turpentine. |
| Larch (Western). ... | Larix occidentalis..... | Oregon ..... | (See also Tamarac.) |
| Laurel (mountain)... | Kalmia latifolia..... | Penn. & southward | Hard, red. Turnery. |
| Leopard-wood or Letter-wood ..... | Piratinera guianensis .. | C. America..... | Hard ; takes a fine polish. Canes, etc. |
| Lignum vitæ..... | Guiacum officinale ..... | W. Indies..... | Hard. Pestles, mortars, turnery, sheaves, bowls, rulers. |

| Name of Tree. | Botanical Name. | Native Place, or where chiefly grown. | Qualities, Uses, etc. |
|---|---|---|---|
| Lignum vitæ | Guiacum sanctum | S. Florida | Hard, dark. Turnery and ornamental. |
| Lime | Tilia europæa | Europe | Close-grained. Carving, hoops, turnery, etc. |
| Linden (Linn, bass-wood) | Tilia americana | Eastern U. S. | Soft, white, flexible. |
| Locust | Hymenæa courbaril | W. Indies | Hard. Timber for steam-engine frames, tree-nails, etc. |
| Locust | Robiuia pseudacacia | East of Miss. River | Tough and durable. Posts, tree-nails, turnery, hubs. |
| Logwood | Hæmatoxylon campechianum | Jamaica, Honduras | Dyeing. |
| Mahogany | Suretema mahagoni | C. America, Cuba | Hard. Furniture, cabinet-work, turnery, etc. |
| Mahogany (mountaiu) | Cereocarpus ledifolius | Rocky Mountains | Hard, dark-red. Ornamental. |
| Mangrove | Various | Tropics | Cabinet-making, shipbuilding. |
| Maple (black) | Acer nigrum | Eastern U. S. | Same as saccharinum. |
| Maple (red) | Acer rubrum | Eastern U. S. | Soft, and less useful. |
| Maple (sugar) | Acer saccharinum | Eastern U. S. | Hard, white. Sugar, earving, gun-stocks, framing-timber, furniture. |
| Mountain-ash | Eucalyptus pilularis | Australia | Hard, tough. Poles and shafts for earts, wagons, etc. |
| Mountain-ash (rowan) | Pyrus aucuparia | Britain, etc. | Similar to the apple. |
| Mulberry | Morus alba et nigra | Europe, China | Leaves, for the silkworm. |
| Mulberry (red) | Morus rubra | Eastern U. S. | Medium, red, very lasting. Posts and framing. |
| Muskwood | Eurybia argophylla | Tasmania and N. S. Wales | Hard; smells of musk; takes a fine polish. Ornamental furniture. |
| Mustaiba | | Brazil | Turning, knife-handles, etc. |
| Myrtle | Myrtus eommunis | S. Europe | Hard. Close-grained; takes a good polish. |
| Myrtle (Tasmauiau) | Fagus cunninghamii | Tasmania | Dark; finely marked. Cabinet-work, turnery, etc. |
| Nellee | | India | Dark flesh-color. |
| Nettle-tree | Celtis australis | S. of Europe | Close-grained. Flutes, earving. |
| Norfolk Island pine | Araucaria excelsa | Norfolk Islaud | Medium. Building, carpentry, etc. |
| Norway spruce | Abies excelsa | Norway | Medium. The white *deal* used in England. |
| Novaladdi | | India | Greenish brown; close-grained; takes fiue polish. |
| Oak | Quereus robur, etc. | Europe, etc. | Hard. Shipbuilding, furniture, turnery, implements. |
| Oak (African) | (See Teak) | Africa | Hard. Shipbuildiug, furniture, turnery, etc. |
| Oak (black) | Quercus tinctoria | Eastern U. S. | Hard, red. Building, shingles. |
| Oak (chestnut) | Quereus prina | Eastern U. S. | Building, fenciug, etc. |
| Oak (red) | Quereus tiuctoria | Eastern U. S. | Hard, red. Buildiug, shingles. |
| Oak (white) | Quereus alba | Eastern U. S. | Hard, yellow. Building, furniture, implements, wagons. |
| Olive | Olea europæa | Europe, Syria, etc. | Medium. Furniture, turnery, etc. |
| Osage orange (Bois d'arc) | Maelura aurantiaca | Ark. and southward | Hard, yellow, very lastiug. Wagons and implements, wedges. |
| Osiers | Salix viminalis, etc. | Europe | Soft. Baskets, plait, wicker-work generally. |
| Oyster Bay pine | Callitris australis | Tasmania | Hard. Agricultural implements, cabinet-work, etc. |
| Paddle-wood | Aspidosperma excelsum | Guiana | Paddles, cotton-gin rollers. |
| Palm | (See Poreupine-wood) | Tropical climes | Various uses in mechanies. Oil. |
| Partridge-wood | Heisteria coccinea, etc. | W. Ind. and S. Am. | Hard. Walking-sticks, umbrella-handles, etc. |
| Pear | Pyrus eommunis | | Turning, earving, blocks for calico-printers, etc. |
| Pheasant-wood | | | Another name for partridge-wood. |
| Pine | Speeies very numerous | Europe and Asia | Medium. Lumber for buildiug aud carpentry. |
| Pine (Cal. yellow) | Pinus jeffreyi | California | Various. |
| Pine (pitch) | Pinus rigida | S. E. Uuited States | Various. Turpentine. |
| Pine (red) | Pinus resinosa | Eastern U. S. | Building, etc. |
| Pine (spruce) | Pinus glabra | S. Car. & southward | |
| Pine (white) | Pinus strobus | Eastern U. S. | Principal timber-tree of North America. |
| Pine (yellow) | Piuus mitis | Northern America | Mediuu, yellow. Building and various. |
| Plane (occidental) | Platanus occidentalis | N. America | Medium; called buttonwood and sycamore. Bedsteads, musical instruments, etc. |
| Plane (Oriental) | Platanus orientalis | Asia | Medium. Joinery, eabinet-work, turnery. |
| Plane or sycamore | Acer pseudo-platanus | Britain, etc. | Soft. Woodeu dishes, carving generally. |
| Plum | Prunus domestica | Britain, etc. | Soft. Turnery, ornamental work, small cabinet-wares. |
| Poon-wood | Calophyllum angustifolia | India | Planks for shipbuilding and spars. |
| Poplar | Populus alba, etc. | Europe and Asia | Medium. Furniture, carving, turnery, etc. |
| Poplar (white, tulip-tree) | Liriodendron tulipifera | Eastern U. S. | Medium. Building, furniture, paper. |
| Porcupine-wood | Cocos nucifera | Tropleal climes | An ornamental wood; takes a good polish. |
| Purple-heart | Copaifera pubiflora | Brazil | Hard. Furniture, beds for mortars, etc. |
| Quassia | | Tropical America | Medicinal. |
| Ratans | Calamus rotang | Tropleal climes | A eane. Brooms, plaiting, lashing, etc. |
| Red sanders | Pterocarpus santalinus | India | Dycing and turning. Called also ruby-wood |
| Redwood | Sequoia gigantea | California | Various. |
| Rhododendron | Rhododendrou (various) | Himalaya | Hard. Close-grained; takes a good polish. |
| Rosewood | Dalbergia (?) | Brazil, C. Am., Ind. | Moderately hard. Pianos, furuiture, turnery, etc. |
| Rosewood (African) | Pterocarpus erinaceus, etc | Gambia | Hard. Piauos, furniture, turnery, etc. |
| Rosewood (Tasmanian) | Acacia (?) | Tasmania, etc. | Hard. Ornamental furniture, turnery, etc. |
| Sandal-wood | Santalum album | India | Soft, fragrant. Fancy boxes, etc., and carving. Colors, white, yellow, and red. |
| Sapan-wood | Cæsalpina sapan | India | Dyeing, turning. |
| Sassafras | Atherosperma moschata | Tasmania | Hard. Flooring of houses, earpenter's bench-screws. |
| Sassafras | Sassafras officinalis | America | Turniug, cabinet-work, and in medicine. |
| Satin-wood | Chloroxylon swietenia | E. Indies | Ornamental cabinet-ware, beautifully marked. |
| Saul or sâl | Shorea robusta | E. Indies | Hard. Carpentry. |
| Scotch fir | Pinus sylvestris | Scotland, etc. | Medium. Affords the yellow *deal* used in England. |
| Service-tree | Amelanchier canadensis | Eastern U. S. | Red, hard, and lasting. Tool-handles, etc. |
| She-oak | Casuarina quadrivalvis | Tasmania | Hard. Cabinet-work, chairs, picture-frames, etc. |
| Silver-wood | Leucadendrou argenteum | Cape of Good Hope | Hard, beautifully marked. Furniture, cabinet-work. |
| Sissoo | Dalbergia sissoo | India | Hard. Shipbuilding, etc. |
| Snake-wood | | W. Indies and S. America | Walking-sticks, etc. Also known as *leopard*-wood and *letter*-wood. Beautifully variegated. |
| Spindle-tree | Eunonymus europæus | Britain, etc. | Soft. Skewers, etc. |
| Spruce (black) | Abies douglassii | Sierra Nevada. | |
| Spruce (Engelmann's) | Abies engelmanni | Rocky Mountains. | |
| Stringy bark | Eucalyptus fabrorum | Australia | Hard. Building, earpentry, etc. |
| Sycamore | Acer pseudo-platanus | Temperate climes | Soft. Wooden platters, turnery, earving, etc. |

| Name of Tree. | Botanical Name. | Native Place, or where chiefly grown. | Qualities, Uses, etc. |
|---|---|---|---|
| Sycamore | Platanus occidentalis | Eastern U. S. | Hard, white, coarse. Turnery, furniture. |
| Sycamore (Fig) | Ficus sycomorus | Egypt | Light. Cases for mummies in ancient times. |
| Tamarac (Am. larch). | Larix americana | N. and N. E. States. | |
| Teak (African) | Oldfieldia africana | W. Africa | Hard. Railway-carriages, shipbuilding, etc. |
| Teak (Indian) | Tectona grandis | India | Hard. Railway-carriages, shipbuilding. |
| Thorn | Cratægus punctata | Eastern U. S. | Hard, light-red. Turnery. |
| Toon-wood | Cedrela toona | Indla | Furniture and cabinet-work. |
| Toqua | | Himalaya | Dark-colored; takes fine polish. |
| Tulip-wood | Harpulia pendula | Australia, etc. | Hard. Veneers, cabinet-work, turnery, etc. |
| Turtle-wood | | Surinam | Turnery. |
| Vegetable ivory | Phytelephas macrocarpa | C. America, etc. | A nut used in turnery. |
| Walnut (black) | Juglans nigra | Eastern U. S. | Medium, dark. Furuiture, ornaments, gun-stocks. |
| Walnut (English) | Juglans regia | Europe, etc. | Hard. Furniture, gun-stocks, etc. |
| Walnut (French) | | Persia, Asia Minor, etc. | *French* is a misnomer. Called in England *Circassion* walnut. |
| Walnut (white) (buttternut) | Juglans cinerea | Eastern U. S. | Soft, pale brown. Furniture. |
| White-wood | Pittosporum bicolor, etc. | N. S. Wales, etc. | Hard; resembles box. Wood-engraver's blocks. |
| Willow | Salix (various) | Europe and Am'ca | Soft. Wooden shoes, pegs, spoons, baskets, plait, hoops. |
| Yacca-wood | | Jamaica | Cabinet and marquetry work and turning. |
| Yew | Taxus baccata | Britain, etc. | Hard. Furniture, turnery, walking-sticks, etc. |
| Yew | Taxus brevifolia | Cal. and Oregon | Hard, red. |
| Zebra-wood | | Brazil | Cabinet-work, brushes, etc. |

**Wood, Ar-ti-fi'cial.** A composition which is plastic when warm or wet (as the case may be), but hardens into a material resembling or having the uses of wood.

The materials are usually selected from among the following: —

Paper, paper-pulp, glue, flour, sawdust, hemp, shavings, ivory and bone dust, albumen, resins, gums, metallic oxides, drying-oils, gelatine, sulpbur, caoutchouc, gun-cotton, gutta-percba, mineral salts.

Tbe means used are pulping or other means of incorporation; pressure in molds, baking, etc., according to material.

The purposes are moldings, veneers, parquetry, tbe usual uses of horn, ivory, hard rubber, bone, etc.

English patents from 1772 to 1865: —

Nos. 1,011, of 1772, Whittock and Hodgson. Composition for carving, casting, or modeling, composed of cartridge-paper, glue, wbeat-flour, beech-tree sawdust, and hemp.

1,573, of 1854, Hitcbins and Batley. Shavings of wood, ivory, and bone, combined with glue, and perfumes added, forming a plastic mass which may be molded by pressure.

2,232, of 1855, F. C. Lepage. Mixture of sawdust and albumen, gelatine, or size, witb vegetable, animal, or metallic powders.

2,359, of 1855, A. Parkes. 1. Oils are treated with chloride of sulphur solution, converting them into a substance resembling vulcanized rubber, whicb may be combined with caoutchouc.

2. To a solution of gun-cotton are added gums, resins, india-rubber or gutta-percba, animal substances, as phosphates of ammonia or magnesia, oxide of cadmium, perchloride of mercury, oxide of tin, alum, etc.

518, of 1858, John C. Martin. Any fibrous substance of which paper may be made, resin, soda or potasb, glue, a drying oil, and sugar of lead.

No. 112, of 1861, C. Stevens. Wood-shavings are treated with caustic lye, rendering the fibers separable. Tbe mass is then fermented, and the resulting paste may be molded into any desired shape.

No 2,680, of 1864, A H. A. Durant. Hemp or other fiber is combined with papier-maché.

**Wood-bend'ing Ma-chine'.** Wood is bent for many purposes: ship-timbers, furniture, plows, and other tools of agriculture, sleigh-runners, carriage-bows and wheel-rims, hoops, staves, etc.

The Vienna bent-wood furniture is very elegant and light, and the Gardner chair-seats of bent and perforated veneers are both strong and well-looking.

The use of heat as an agent in bending wood was known to the ancients. In the "Argonautics" of Valerius Flaccus, we read of the building of the renowned ship "Argo." The passage has been rendered thus: —

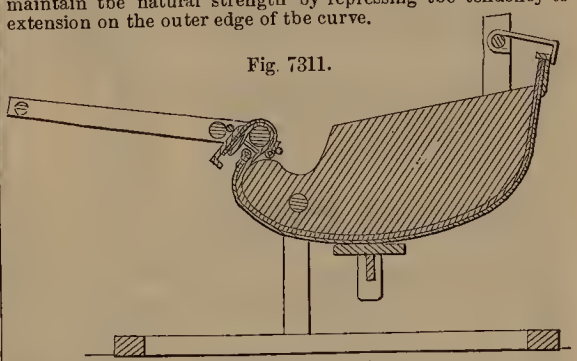
> "The bustling throng of men, and groves he sees
> Hewn down, and axes sounding through the shores;
> With the thin saw how Tiphys slits the pine,
> And joins the sides, he views: *how stubborn beams*
> *Relent and soften to the suppling fire.*"
>
> Book I., verse 125.

Theocritus, the Greek poet, describes the chariot-maker bending a heated woodeu tire to form "tbe circumference of a chariot-wheel." Tbe wood is described to be that of a wild fig-tree. The Egyptians also bent their tires.

It is found that while the compression of the fibers of wood in bending but slightly impairs their strength, the effect of stretcbing is to permanently weaken them. By placing the piece of wood in an iron frame wbich prevents any elongation and causes tbe whole bending to take place by compression, tbe piece is not rendered sensibly weaker.

Many of the patented improvements are to enable the wood to be so clamped as to prevent cracking or cbecking, and to maintain tbe natural strength by repressing tbe tendency to extension on the outer edge of tbe curve.

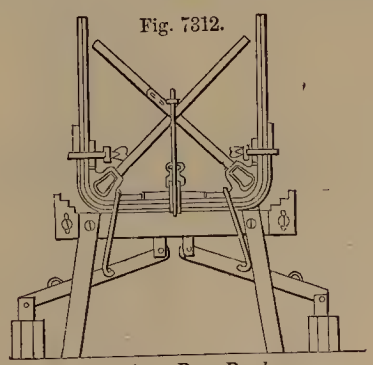
Fig. 7311.



*Sleigh-Runner Bender.*

Fig. 7311 is a means for bending sleigh bodies or runners. The flexible metallic band binds the strip upon the *former*, and has an eye on its end through which the strip is passed to be grasped by the clasp on tbe roller, which forms the front curve of tbe runner.

Fig. 7312.

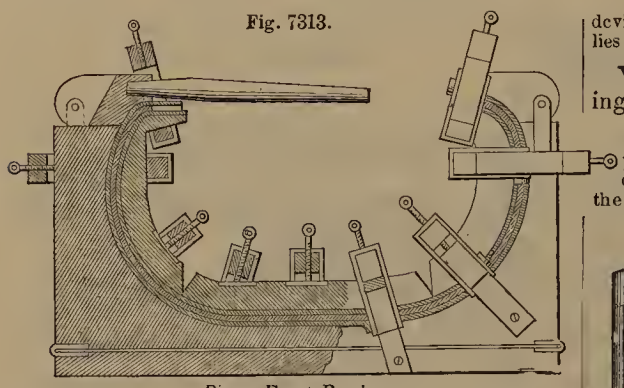


*Carriage-Bow Bender.*

Fig. 7312 is a carriage-bow bender. Tbe strips are supported, when the bending begins, by the flexible plate that presses the strips against tbe *formers* to prevent their being abruptly bent and broken.

Fig. 7313 is to bend the front of pianos, when built up of thin sheets of wood and veneered, and it consists of a concave

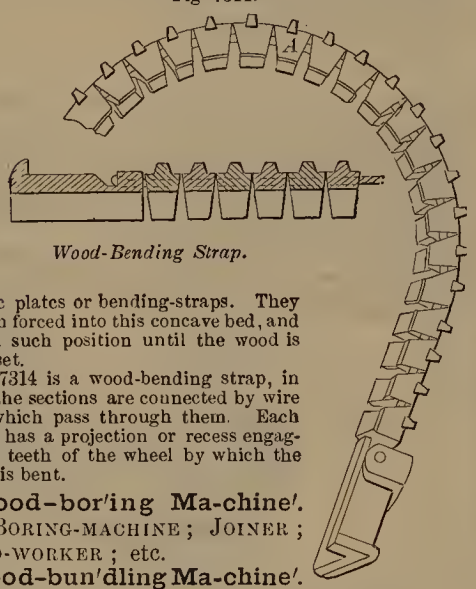
Fig. 7313.



*Piano-Front Bender.*

bed, having the form of the front and corners of piano-frames, in which the thin sheets that form the frame are glued together and veneered on the two sides, and held between heated metallic plates or bending-straps. They are then forced into this concave bed, and held in such position until the wood is firmly set.

Fig 7314.



*Wood-Bending Strap.*

Fig. 7314 is a wood-bending strap, in which the sections are connected by wire ropes which pass through them. Each section has a projection or recess engaging the teeth of the wheel by which the timber is bent.

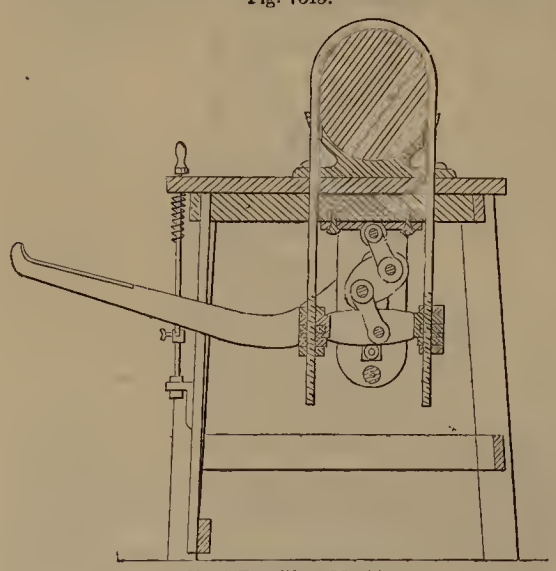
**Wood-bor'ing Ma-chine'.** See BORING-MACHINE; JOINER; WOOD-WORKER; etc.

**Wood-bun'dling Ma-chine'.** A machine for clamping firewood in bundles, to be tied.

Such usually have a pair of clamping-jaws which grasp the sheaf of sticks tightly while being tied with wire or string.

Fig. 7315 is a machine in which the lever, by intermediate devices, tightens the gripping bow upon the split wood that lies in a slotted cradle, and holds it firmly for binding.

Fig. 7315.

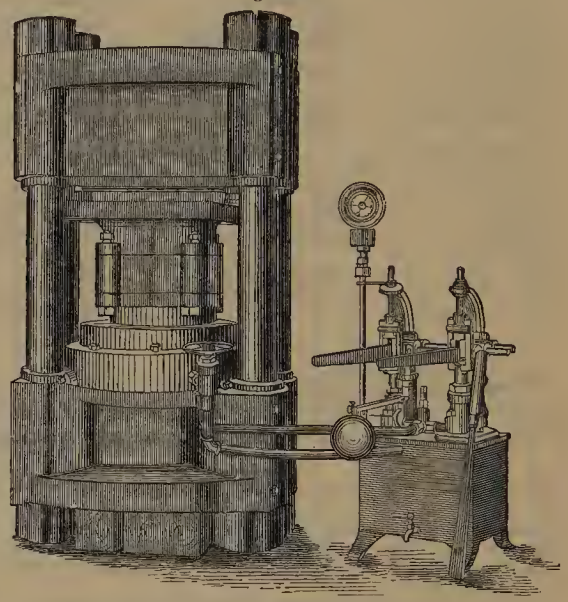


*Wood-Bundling Machine.*

**Wood'bur-y-type.** A process of photo-engraving and printing, invented by Mr. Walter Woodbury.

A plate, coated on one side with a solution of bichromate of potash or bichromate of ammonia, in gelatine, is exposed, in contact with a negative, to the light, which, passing through the unshaded portions of the negative, renders certain portions of the gelatinous film insoluble, while the other parts remain more or less soluble, in proportion to the intensity of shade in the negative.

Fig. 7316.

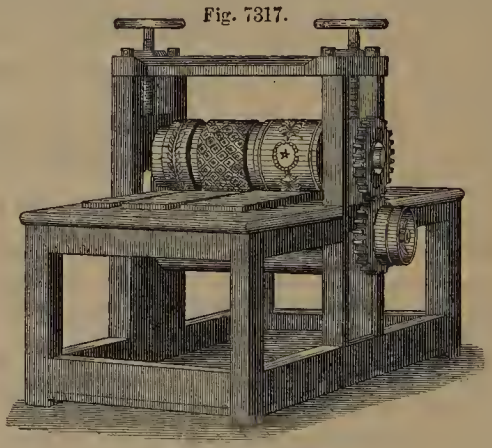


*Press used in the Woodbury Process.*

The plate is then placed in a bath of warm water, and the soluble portions of the gelatine removed. This leaves the gelatinous film in the condition of a woodcut, the shades being in relief and the lights in intaglio.

It is, after becoming dry and hard, placed in a hydraulic press (Fig. 7316), covered with a plate of type-metal, and subjected to a powerful pressure, which gives a reversed impression of the gelatinous film, the lights being in relief and the shades in intaglio, enabling the plate to be printed from after the manner of a copperplate-engraving. In order to bring out the half-tones, a peculiar ink is employed, consisting of gelatine holding coloring-matter in solution, by which the effect of a water-color drawing is produced, the paper absorbing from the plate a quantity of ink proportional to the depth of each depression.

Fig. 7317.



*Wood-Carving Machine.*

Several printing-presses, of very simple construction, are placed on a revolving-table, which is turned to bring each of them successively to the hand of the operator, who applies the paper and ink, and waits until the same press comes around again to remove the picture, in order to allow the impression time to become fixed.

**Wood-car'pet.** A floor-covering made of slats or more ornamental shapes, glued or cemented upon a cloth backing. The slats or strips of wood are of different colors, and are arranged to produce all the effects of tessellated floors, mosaic work, etc., and, being about one fourth of an inch in thickness, they will wear many years. They are finished in oil.

**Wood-carv'ing Ma-chine'.** A machine by which designs and patterns resembling carved work are produced in wood by pressure. The material is passed between a bed-plate and a die-cylinder, on which the required design is cut. See also Fig. 1169, page 492.

**Wood'cock-eye.** An English name for a snap-hook.

**Wood'cut.** See WOOD-ENGRAVING.

**Wood-em-boss'ing.** One form of wood-*carving*, so called, is made by softening and then pressing in molds; another is a burning process. See Braithwaite's, mentioned on page 492.

In a Parisian process known as Xyloplasty, the wood is softened by steam, and imbued with certain ingredients, which impart to it sufficient ductility to enable it to receive has-relief impressions from four to five millimetres in hight. For medallions, hosses, etc., mastic is forced into the hollows, so that all tendency in the compressed wood to split or open is completely overcome. For hook-binding purposes much seems to be expected from this process, as it is applicable to the scented or odoriferous woods — cedar, teak, cypress, rosewood, etc. — which repel worms.

**Wood'en Brick.** A brick-shaped block built into a wall, to afford nail-hold in securing the inside wood-work.

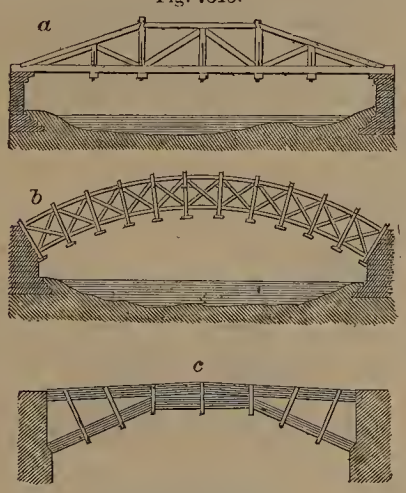
**Wood'en Bridge.** One altogether of wood, or a wooden frame resting upon masonry piers.

The bridge across the Euphrates, at Babylon, described by Herodotus as built hy Nitocris, consisted of wooden spans supported on stone piers. The latter were constructed during a temporary deviation of the river into a vast basin excavated to form a lake. (HERODOTUS, I. 186.)

The bridge across the Tiber, the Pons Sublicius, was made of wooden beams, as its name indicates. It was built hy Ancus Martius when he united the Janiculum to the city of Rome, and is renowned as the scene of the exploit of Horatius, when Rome was attacked by "Lars Porsenna of Clusium." It was still a wooden bridge in the time of Augustus, and was carried away by a flood in the time of Otho. It was situated at the foot of the Aventine mount.

Cæsar's bridge, over the Rhine, 55 B. C., was of wood, built upon piles (Fig. 924, *a*). Cæsar tells us that two timbers, 18 inches square, and pointed at their lower ends, were sunk into the river, and afterward driven 2 feet distant from each other by machines; these piles were slightly inclined; two others were driven opposite to them, at a distance of 40 feet, inclining in the contrary direction; the two pairs were connected at the top hy a transverse beam 2 feet thick, and over these were laid joists in the direction of the breadth of the river, which were covered with hurdles, to sustain the road. On the down-stream side inclined piles were driven, to support the bridge against the force of the curreut; and above the bridge were

Fig. 7318.




*Wooden Bridges.*

others, to protect it from injury against floating objects. It was completed in ten days.

The bridge of Trajan, across the Danube, had 22 wooden arches and 23 piers. It was 3,010 feet long and 48 feet high. It was destroyed by Hadrian, professedly to prevent incursions of the barbarians on the north of the Danuhe, hut possibly to remove a great work which dwarfed his own memorials. He also put to death the architect, Artemidorus. See Fig. 924, *b*, page 379.

In small wooden bridges the pieces running from pier to pier are called *sleepers*, or *string-pieces*. These support the *cross-joists*, on which the *planking* is laid. Caps on the pier-posts, to shorten the bearing of the sleepers, are called *bolsters*.

The wooden bridges of the Middle Ages were generally supported upon piers composed of one or more rows of piles, and sufficiently near together to be connected by single timbers of moderate length. This very simple construction did not admit of long spans.

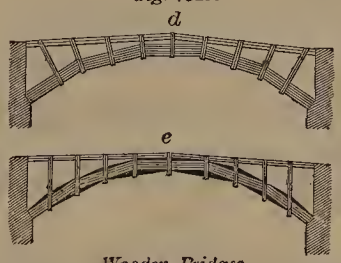
In the works of Palladio we find examples of the truss. Fig. 7318, *a*, shows a bridge of his over the turret of Cismone, near Bassano, having a span of 108 feet. Fig. 7318, *c*, is another bridge, by Palladio, over the Brenta.

A third bridge, by the same architect, on the arch principle, is shown in Fig. 7318, *b*. Each compartment corresponds to a voussoir in a masonry arch.

These constructions enable short timbers to be used for a comparatively long span. The joints, however, cannot be made very strong, and tend to diminish the stahility of the structure, so that it sooner gives way under the jarring strains to which it is exposed.

Fig. 7319, *d*, shows one of the wooden arches, 49 feet in span, over the Thames, at Kingston. This approaches in form the continuous curved rib, which is, however, a more solid construction, being built up of pieces, arranged to hreak-joints, and bolted together, so as to act as a solid mass (Figs. 312-316). This principle has been adopted in many bridges of consider-

Fig. 7319.




*Wooden Bridges.*

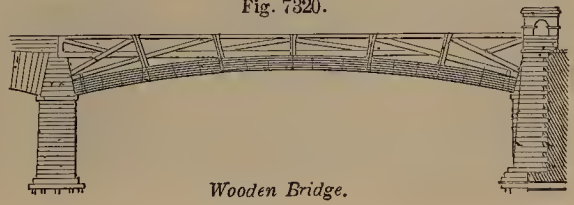
able magnitude, both in Europe and America, among others that over the Regnitz, near Bomberg, designed by Wiebeking, and built in 1809 (*e*, Fig. 7319).

The celehrated wooden hridge over the Rhine, at Schaffhausen, erected in 1757, had a span of 364 feet. A stone pier, the relic of a former structure, existed near the middle of the stream, but it is said that the builder, Ulric Grubenmann, though erecting the bridge directly over this pier, in deference to the timidity of the authorities, apparently using it for a central support, purposely took care that the hridge should not rest upon it. The hridge was destroyed by the French in 1799. Both Ulric Grubenmann and his brother John displayed great skill and boldness in their bridge constructions. John huilt a timber-bridge at Kirchenaw, 240 feet in length; and the two, conjointly, one near Baden, 200 feet in length, and another, at Wattenghen, 198 feet long.

The two leading forms of modern wooden bridges are the lattice, in which the principle of the truss is employed; and the arched, which derives its strength from the actual compression of the wood, the ends, as in other arched structures, resting upon and pressing against abutments. This is the style of bridge which appears to have been principally employed in Europe; while the lattice, or truss, or some combination of it with the arch, has been very extensively made use of in the United States. One of the best examples of the former, the bridge over the Limmat, in Switzerland, was huilt shortly after the middle of the eighteenth century, by the Grubenmann brothers; the span of its wooden arch was 390 feet, with a rise or versed sine of 43 feet; this is said to have been the widest span ever formed of timber.

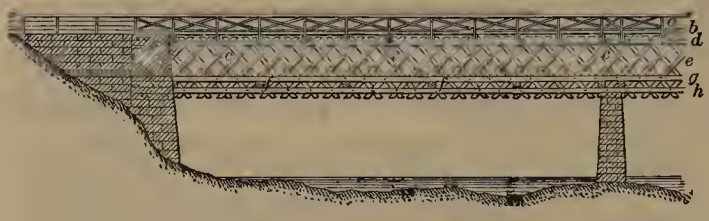
A bridge over the Seine, at Paris, built in 1802, has a span of 104 feet, with a versed sine of but 6 feet 6 inches. The lattice

Fig. 7320.



*Wooden Bridge.*

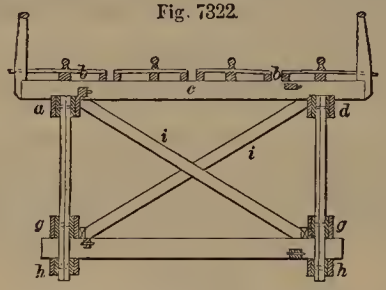
Fig. 7321.



*Town's Lattice-Truss (Side Elevation).*

bridge has generally, in practice, where great strength and rigidity are required, been combined with the arch, though examples of smaller structures more especially, in which the whole weight of the bridge and its load are borne by the truss, are extremely common. The widest single-span wooden bridge ever built in the United States is believed to have been that over

Fig. 7322.



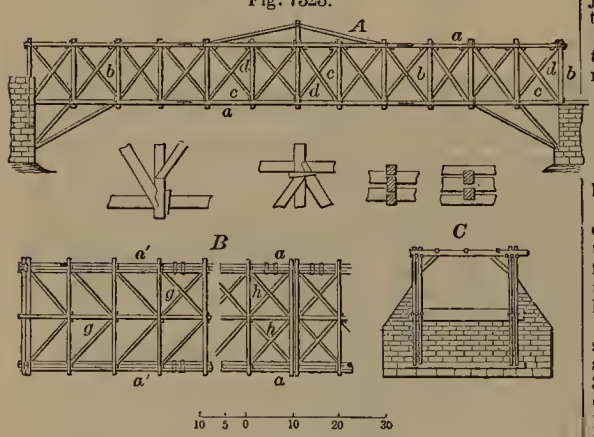
*Town's Lattice-Bridge (End Elevation).*

the Schuylkill, at Fairmount, destroyed by fire in 1838. It had a span of 340 feet.

Among the various forms of bridge-truss employed in the United States may be cited those of Town, Long, Burr, Howe, and McCallum.

Town's lattice-truss (Fig. 7321) has been employed for spans up to 150 feet. The roadway *a* rests upon sleepers *b*, which

Fig. 7323.



*Long's Wooden Bridge.*

are supported on the transverse beams *c*; these rest on the stringers *d d*, secured by tree-nails to the lattice-ribs *e e*, at their upper crossings. Lower cross-beams *f*, and two lines of stringers *g h*, one above and the other below the cross-beams, and

Fig. 7324.

*Burr Truss.*

diagonal braces *i i*, with some auxiliary pieces, complete the framing.

The depth of the lattice-work is proportioned to the width of the span. In that illustrated, the span is 78 feet, the depth 9 feet 6 inches. Fig. 7321 is a side and Fig. 7322 an end elevation.

Long's (Fig. 7323) has been employed for spans of 150 feet. The example is 110 feet, with a depth of 15 feet. *a a'* are the

Fig. 7325.

*Improved Howe Truss.*

longitudinal stringers, supporting the roadway, *b b* the posts, *c c* main braces, *d d* counter-braces. The frames are connected at top and bottom by cross-beams *e f*, the latter supporting the roadway. Diagonal braces, marked *g* at top and *h h* at bottom, serve to stiffen the framework laterally. *A* is an elevation; *B* a plan of the top, and *C* of the bottom of the frame. The posts and braces are secured to the stringers by wedges, so that the

Fig. 7326.

*McCallum's Inflexible Arched Truss.*

joints may be readily tightened up, and the whole easily put together or taken apart.

The Burr truss (Fig. 7324) was extensively used in this country prior to the era of railways. It answered very well on common roads, and where sufficient rise was given to the arch, but, owing to the difficulty of combining the principles of the arch and truss, and the absence of counter-braces, was not found sufficiently enduring for railway travel.

The Howe truss has counter-braces, and vertical iron tension-rods were used instead of posts. Fig. 7325 represents what is known as the improved Howe truss.

McCallum's inflexible arched truss (Fig. 7326) has braces and counter-braces; the spaces between the posts are diminished toward the ends of the spans, and diagonal braces, tending from the piers and abutments toward the middle portion of the upper arched beam, tend to reduce the tension upon the lower chord.

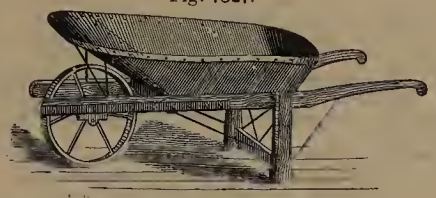
Bridge-building was one of the arts brought to the greatest state of perfection during the late civil war. General McCallum states that the Rappahannock River bridge, 625 feet long and 35 feet high, was rebuilt in nineteen working hours; Potomac Creek bridge, 414 feet long and 82 feet high, in forty working hours; Chattahoochee bridge, 780 feet long and 92 feet high, in four and a half days; that between Tunnel Hill and Resaca, 25 miles of permanent way and 230 feet of bridges, was constructed in seven and a half days; and near Big Shanty 35½ miles of permanent way and 455 feet of bridges, in thirteen days.

The following are the dimensions of some of the best known timber bridges: —

| Name. | River. | Place. | Widest Arch. | | Curve. | Architect. | Date. |
|---|---|---|---|---|---|---|---|
| | | | Span. | Rise. | | | |
| | | | Ft. | Ft. In. | | | |
| Colopus | Schuylkill | Philadelphia | 340 | 20 0 | Segment. | Wernwag | 1813 |
| Piscataqua | Piscataqua | New Hampshire | 250 | 27 4 | Segment. | Palmer | 1794 |
| Bamberg | Regnitz | Germany | 208 | 17 4 | Segment. | Wiebeking | 1809 |
| Trenton | Delaware | Pennsylvania | 200 | 32 0 | Segment. | Burr | 1804 |
| Writtenghen | Rhine | Switzerland | 198 | 30 10 | Segment. | Grubenmann | 1777 |
| Pont Louis | Iser | Freysingen | 154 | 13 6 | Segment. | Wiebeking | 1809 |
| Ellicott's Mills | Patapsco | Maryland | 150 | 20 0 | Lattice | Unknown | 1838 |
| Erie Railway | Portage | New York (1,000 ft long) | ..... | ..... | Trestle | ..... | .... |

See also TRESTLE.

Fig. 7327.



*Foundry-Barrow.*

**Wood'en-frame Bar'row.** One with an iron box, for foundry purposes.

**Wood-en-grav'ing.** Wood-engraving, or the making of woodcuts, differs from plate-engraving in the fact that the design in the former is in cameo, while the latter is in intaglio. It is difficult to assign a date to the invention, as the signets of royalty in ancient times were made upon the same principle, if not with similar tools, upon the same material. The Chinese, as usual, seem to have had the art from a very ancient date. (See PRINTING.) Our friends on the Continent of Europe claim that the manufacture of cards first called woodcuts into existence. It may have suggested the use of the art, and it may have arisen by an original process of thought, but it was certainly long antedated by the ancients and Orientals.

The gravers used in this branch of the art of engraving are more numerous than those in plate-engraving. The same angular-edged gravers are used, together with others much more acute-angled, and farther a variety of tools with flat and rounded bellies of varying widths for cutting tints and for gouging out the intervals. See TINT-TOOL.

Box-wood is used for the best work. Pear and sycamore are in favor for common work. The blocks are sawn *across* the log, so that the section or block stands with the grain vertical during engraving and in the press. The blocks, when their surfaces are finished, are of a thickness exactly equal to the length of a type, with which they are associated in the chase, for printing.

Bewick, born 1753, died 1828, was the restorer of the art, giving grace and graphic effect, where conventional dreariness before existed.

Stereotype or electrotype impressions are obtained from wood by the usual process of molding in plaster of Paris and subsequent casting, or brushing with graphite and electro deposit.

Woodcuts have also been multiplied by molding with warm gutta-percha, and then taking a cast of the same gum, to be used as a woodcut in the printing-press.

**Wood'en Leg.**

"Inepte, frustra crure ligneo curres." — MARTIAL, X. c. 6.

See LEG, ARTIFICIAL.

**Wood'en Pave'ment.** See PAVEMENT, pages 1639-1642, and Plate XXXVIII.

The experience of American cities which have used wood-pavement goes to show that some system of preservation is necessary to secure a durable wood-pavement.

If the question of wood-preservation is not finally and perfectly solved, it must be admitted that the methods now in use show a decided progress in that direction. The respective efforts tend to neutralize the external influences of water, air, and heat, by

First. A more or less complete removal of the water and extraction of the aqueous solutions of vegetable matters contained in and between the cells and fibers of the wood. This is done mostly by pneumatic process, in iron air-tight cylinders.

Second. A subsequent injection of fluids under hydrostatic pressure, by means of which permanent chemical combinations are formed. These antiseptic fluids are either diluted *metallic solutions* (impregnation proper) or those *oily substances* obtained from the distillation of tars. The oils, which are obtained at certain temperatures of distillation (varying from 180° to 230° Fah.), are charged with substances (also the product of the distillation) which coagulate all albuminous matter, rendering it insoluble, and, in some degree, fixed. This action penetrates even the cells where this albuminous matter is mostly found. Besides the chemical action of this kind of treatment, it also acts mechanically by repelling water, or at least reducing absorption measurably; and in the Robbins process, if thoroughly carried out, the pores become more or less closed with resinous matters. The following processes have been used, namely: —

1. First class, or impregnation with metallic solutions.

(*a.*) Burnettizing, or impregnation of chloride of zinc.

(*b.*) Samuels's process of impregnation with sulphate of iron.

2. Second class, or injection of oily substances.

(*a.*) The Seeley process; impregnation with creosote, carbolic acid derived from pine tar.

(*b.*) Robbins's process; impregnation with heavy oils charged with creosote, carbolic acid, etc., derived from coal-tar at a higher temperature than by the Seeley process.

Where *ironizing* has been tried, reports from various cities are unfavorable. This stands to reason, since sulphate of iron is well known to have no affinity for the formation of insoluble combinations with the vegetable matters to be neutralized, nor has it hardly any poisonous action on low organisms when applied in diluted solutions. The disengagement of sulphuric acid, in consequence of oxide of iron being fixed upon the fibers, also tends to exercise a destructive influence on the texture of the wood, being so much stronger than the hydrochloric acid that may be liberated by the Burnettizing process. The function of the acids being that of merely conveying metallic oxide, of course the use of the weaker acid is preferable.

Creosoted wood has, in some cases, proved offensive. It has to be handled with great care by the workmen, as it produces eruptions and sores, and in Belgium its use for preserving telegraph-poles was abandoned on account of this; otherwise it is efficient and lasting. See WOOD, PRESERVATION OF.

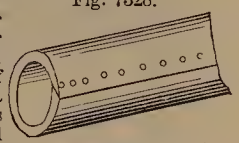
**Wood'en Pipe.**

Wooden pipes (*canules ligni*) were common in ancient Rome in ordinary structures. Lead was used for the superior class of work, in conducting the water of the aqueducts to the fountains and baths. See AQUEDUCT.

Pipes made of elm logs, bored, were used for the mains in the London water-works from 1582, when Morice started the works at London Bridge, down to about 1800. Lead-pipes had previously been used, as early as 1285, in bringing water from the springs of Tyburn to the city, and were also used by Morice for distributing-pipes. When it was determined, about 1800, to replace the wooden mains by cast-iron pipes, the New River Company had 400 miles of wooden mains, which were taken up, and iron substituted, at the rate of twenty miles per annum. The iron mains vary from 1 to 3 feet in diameter.

In the plan adopted at Ithaca, N Y., the pine or other lumber is sawed into lengths of proper thickness, and by peculiar hollow augers, of different sizes, is cut or bored out in concentric tubes or pipes, only leaving at last a small core, a little less than the bore of the smallest pipe. In this way a piece of timber, originally 10 inches in diameter, will *turn out* several pipes of say 10, 8, 6, 4, and 3 inches in outer diameter, and about 1½ inches in thickness, or of greater thickness if required, by decreasing the sizes of the inner tubes proportionately. The hollow auger cuts away only from ½ to ¾ of an inch. This piping is then properly strengthened by iron bands, and subjected to a bath of asphaltum or other cement to make it impervious to gas or water, and to prevent decay.

Fig. 7328.



*Lap-Seam Wooden Pipe.*

In Brisbane's pipe, the boards are steamed and bent longitudinally in cylindrical form till the edges lap on each other, and are then riveted.

**Wood'en Rail'way.** The old form of tramway laid down in the English colliery region about two centuries since; at Newcastle, in 1676; Whitehaven, 1738. Subsequently the wooden rail received an iron plate, as with our own early *strap-rail* system; eventually the iron rail was substituted. See RAIL.

As a cheap expedient the wooden rail is being revived in remote situations where wood is very abundant, money scarce, and iron difficult to procure.

A wooden railway on the 4 feet 8½ inch gage has been constructed from the town of Sorel, at the confluence of the Richelieu River with the St. Lawrence, through Drummondville, to Athabaska, province of Quebec. The ties of hemlock and tamarac are brought down on trucks from the woods through which the railway runs; they are put on a rollway, run up to circular saws, so gaged that at one operation they are *gained* the proper depth and distance, for the reception of the rails. As fast as they are cut they are sided by another circular saw. The rails are of maple, four by seven inches, and 14 feet long, the gage of the line being 4 feet 8½ inches. Each rail lies on seven sleepers, to which it is fastened by wedges. The cost of the line, in which cost are included nine stations, car and locomotive depot, engine and repairing shops, engine and tender, two passenger-cars, eight grain-cars, and twenty-five wood-cars, is $5,000 a mile, in full for all but the Yamaska Bridge, which cost $35,000. Land damages, fences, etc., are included, also, in this amount.

**Wood'en Screw.** A screw of wood; such as is used in the clamping-jaw of a carpenter's bench, or in the clamp of the joiner.

**Wood'en Shoe.** See SABOT, page 2008.

**Wood'en Type.** Large type, cut in wood, for posters, etc.

**Wood'en Ware.** A specific term for vessels, such as bowls, platters, spoons, butter-prints, etc., turned from wood; or, more generally, domestic wooden articles of merchandise.

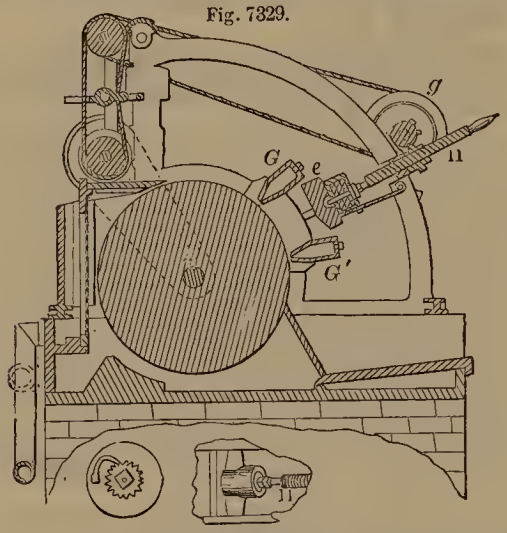
**Wood'en Wing.** (*Nautical.*) A ice-board.

**Wood-gear.** Cog-wheels of wood; used sometimes in roughly made cider mills and presses, etc. Also formerly in clocks. Apple, pear, dog, and box wood are good timber for the purpose.

**Wood-grind'er.** A machine for rasping wooden blocks, to make paper-pulp. See WOOD-PAPER; PULP-GRINDER.

Voelter's machine for grinding paper to pulp has a rasping-mill in which the fibers of wood are torn off and separated from

Fig. 7329.




*Voelter's Wood-Grinder.*

the wooden block by the action of a cylindrical stone against which it is pressed. This stone has a diameter of 48 inches, 16 inches width of face, and makes 150 rotations per minute. Running 24 hours, it will produce 1.000 pounds of pulp per day, the pulp estimated in its air-dry condition, in which it is in the proper state for transportation, but is one half water. The pulp is one half the weight of the wood. Fig. 7329 shows the grinder, and Fig. 7330 the strainer and sorter.

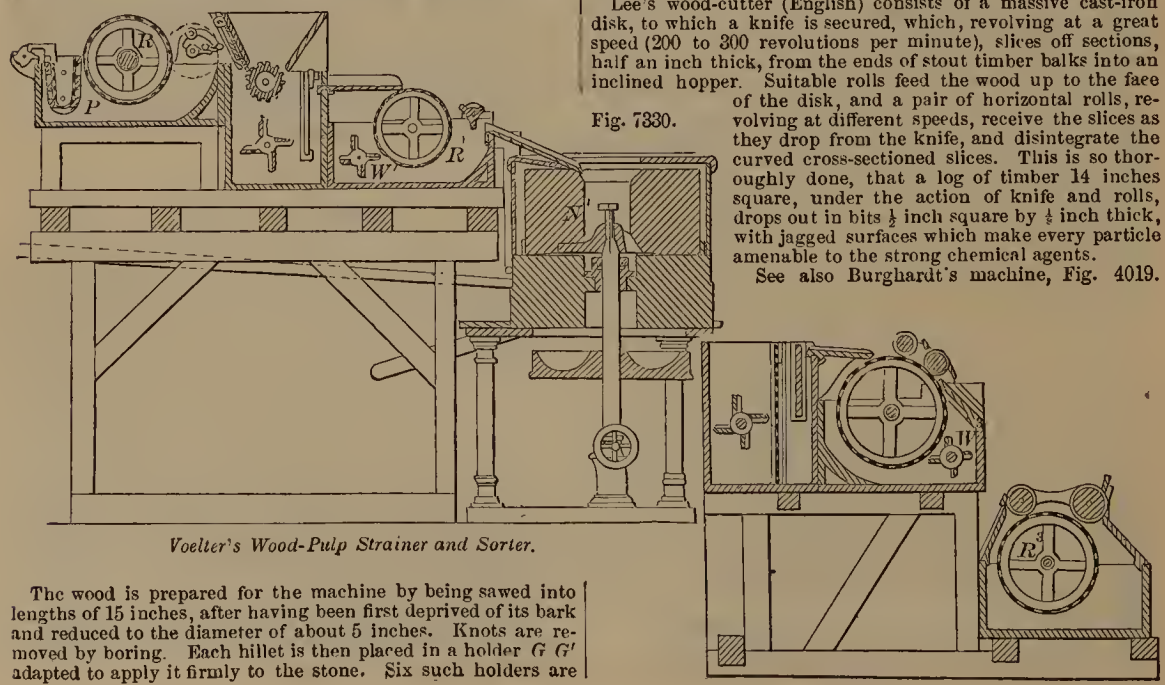



Fig. 7330.

*Voelter's Wood-Pulp Strainer and Sorter.*

The wood is prepared for the machine by being sawed into lengths of 15 inches, after having been first deprived of its bark and reduced to the diameter of about 5 inches. Knots are removed by boring. Each billet is then placed in a holder *G G'* adapted to apply it firmly to the stone. Six such holders are attached to the machine (though but one is shown in the cut), and occupy about one quarter of a circumference. The pressure is applied by means of a screw (11) behind each follower *e*, which is very gradually driven by the machine itself. A single band acts at once upon all these screws by intermediate mechanism; and in case the several billets are not ground off with equal rapidity, the proper adjustment effects itself by the slipping of the band *g*.

The stone is inclosed in an iron box, and water flowing in constantly at the top removes the disintegrated fibers as fast as they are produced. From the mill, the comminuted mass is carried along, in suspension in water, into the first tank *P*, in which there is a cylindrical strainer *R*, formed of very coarse wire-gauze, constantly in revolution. The discharge from this tank takes place from the axis of this strainer, which is made large and tubular for the purpose. The flow is, therefore, from the exterior to the interior, through the meshes of the strainer; and the slivers and coarser fragments of the wood, being thus preveuted from passing, are from time to time removed. The water, with the available portion of the fiber, is discharged through a lateral duct into a second tank $W^1$ at a lower level, where it undergoes a straining similar to the preceding, but through a gauze considerably finer. The process is repeated until the pulp has undergone four successive strainings, when the material is passed into a fourth tank, in which the strainer $R^3$ is so fine as to allow the water only to pass. Between the second $W^1$ and third $W^3$ of these straining-tanks is a grinder $N'$, which reduces the coarser fragments detained by the second drum $R^1$. The 3d and 4th cylinder-strainers constitute a sorting-apparatus, and furnish pulp of successive degrees of fineness.

The preferable woods for this purpose are pine, fir, poplar, linn (linden or bass), birch, perhaps about in the order named; the latter, together with beech, being used much in France and Belgium, where these trees abound. Poplar is principally used in the United States and makes a whiter pulp than fir.

Fig. 7331 is Marx's apparatus, in which several boxes are arranged around the periphery of the rough-faced revolving grindstone, and in each blocks of wood are forced edgewise against the grinding surface, by followers actuated by gearing and weights, while a stream of clear water is poured upon the surface. The pulpy result is sorted by a series of sieves, and discharged into different receptacles, according to quality.

See also Fig. 4018.

In Fig. 7332, the blocks of wood are held against the grindstone by a series of chains, partially surrounding the blocks, and kept tense by a pendent weight. After being coarsely ground, the wood particles pass between the lower surface of the same grindstone and a stationary stone, and are thus comminuted.

Fig. 7333 is Negri's machine for reducing wood to fiber for the formation of paper-pulp. It consists of a casing *a* having a hollow cylinder *b* eccentrically journaled therein, and rotated by belt and pulley. The cylinder *b* has a series of peripheral slots in which cutters are fixed, leaving sufficient spaces for the shavings, as they are detached, to pass into the interior. The blocks of wood are fed into the mouth *c*, and, by the rotation of the cutting-cylinder, are carried around the winding tapering passage *c c* until they are entirely reduced to fine cuttings. See PULP-GRINDER, Figs. 4015–4018. See also PULP-DIGESTER, PULP-DRESSER, etc., pages 1821–1825.

Lee's wood-cutter (English) consists of a massive cast-iron disk, to which a knife is secured, which, revolving at a great speed (200 to 300 revolutions per minute), slices off sections, half an inch thick, from the ends of stout timber balks into an inclined hopper. Suitable rolls feed the wood up to the face of the disk, and a pair of horizontal rolls, revolving at different speeds, receive the slices as they drop from the knife, and disintegrate the curved cross-sectioned slices. This is so thoroughly done, that a log of timber 14 inches square, under the action of knife and rolls, drops out in bits ½ inch square by ⅛ inch thick, with jagged surfaces which make every particle amenable to the strong chemical agents.

See also Burghardt's machine, Fig. 4019.

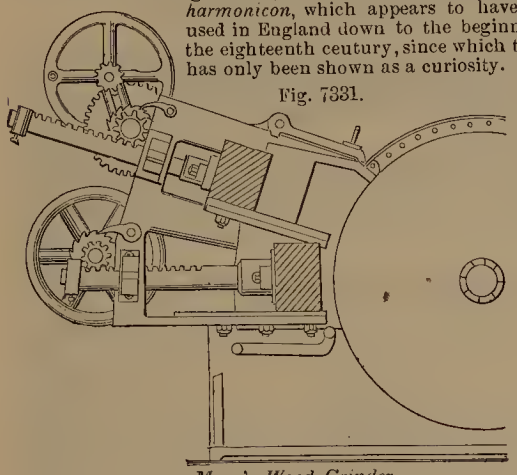
Kingsland's machine, Fig. 4015; Jones's, Fig. 4016; Sellers's, Fig. 4014; and that shown in Fig. 4017, are for acting upon material partially reduced.

**Wood-hang'ing.** Thin veneer on a paper backing, to be used as wall-paper.

**Wood-har-mon'i-con.** (*Music.*) The instrument with bars of sonorous wood is shown in Plate CIII., Bonanni's "Istromenti Armonici," Roma, 1776.

The name *regal*, besides being formerly applied to a small keyed instrument of the organ class, was also used to denote a *wood-harmonicon*, which appears to have been used in England down to the beginning of the eighteenth century, since which time it has only been shown as a curiosity.

Fig. 7331.

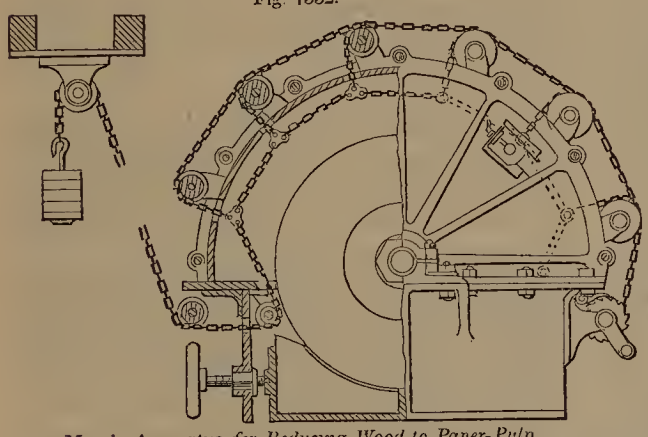


*Marx's Wood-Grinder.*

The resonant powers of some kinds of wood are well understood among the Orientals. Besides the batous, castanets, and *bones* (so called), are instruments in which bars of different sizes are arranged and tuned in octaves like the stone-harmonicon (see LAPIDEON) and the glass-harmonium (see HARMONICA; DULCIMER).

Fig. 7334 shows a Burmese wood-harmonicon described by Captain Yule in his "Missiou to Ava." It is well known

Fig. 7332.



*Marx's Apparatus for Reducing Wood to Paper-Pulp.*

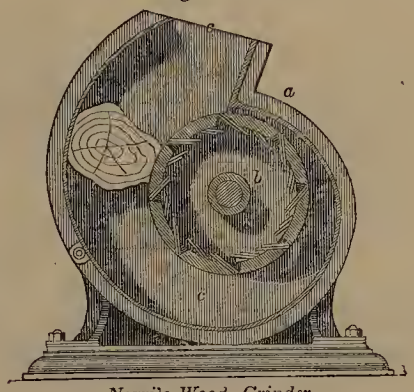
through the East Indian Archipelago, though it has not been noticed in Hindostan. Something like it is also used by the negroes in Brazil. In the upper figure, 18 to 24 flat slips of bamboo, about 1½ inches broad and of graduated length, are suspended in a catenary over the mouth of a trough-like sounding-box. The round outside of the bamboo is uppermost, and while the extremities of the bamboo are left of their original thickness, the middle part of each is thinned and hollowed out below; by this thinning and the proportioning of the length, the bars are tuned. The instrument is played with two drumsticks, like the familiar little glass dulcimer.

A similar instrument in which slips of iron or steel were substituted for the wooden bars was to be seen at the capital of Burmah, and was said to have been made by King Tharawadee himself, a monarch who, like Louis XVI., cared more for iron work than regal honors.

The lower figure shows a Burmese guitar of three strings in a frame shaped like an alligator and receiving its name from thence. It is laid on the ground before the performer.

The *fang-hiang*, or wood-harmonicon of the Chinese, had 16 slabs of an oblong shape suspended in a wooden frame. The

Fig. 7333.




*Negri's Wood-Grinder.*

slabs were arranged in two tiers one above another, and were of equal length and width, but different thickness.

The *king*, or stone-harmonicon, of the Chinese is composed of slabs of sonorous stone, and is said to have greatly charmed Kung-fu-tze, 500 B. C. The *yu* is the favorite stone, and is probably an agate. The *pien-king* is a modern form, and is tuned in intervals called *lu*, twelve in the compass of an octave.

The stones are suspended by strings and tuned by chipping or grinding to a size or thickness. Such were used among the Peruvians before the conquest. Also used in Central Africa and Angola.

**Wood-lock.** (*Nautical.*) Blocks in the scores of the stern-post to keep the rudder from lifting off its bearings.

**Wood-pa'per.** Paper made of wood reduced to a pulp by mechanical or chemical means; more usually by a combination of the two.

Oriolli's plan was to treat the wood with a [dilute?] mixture of hydrochloric acid, 80; nitric acid, 20 parts, for 24 hours; in stone reservoirs. Wash; press in a mortar; wash; neutralize the acid by a 10 per cent soda lye; bleach with 10 per cent

Fig. 7334.

*Wood-Harmonicon.*

chloride-of-lime bath. The difficulty of providing reservoirs and the unhealthiness of the fumes were unsurmounted difficulties, and the process is principally interesting as leading to effective methods which followed.

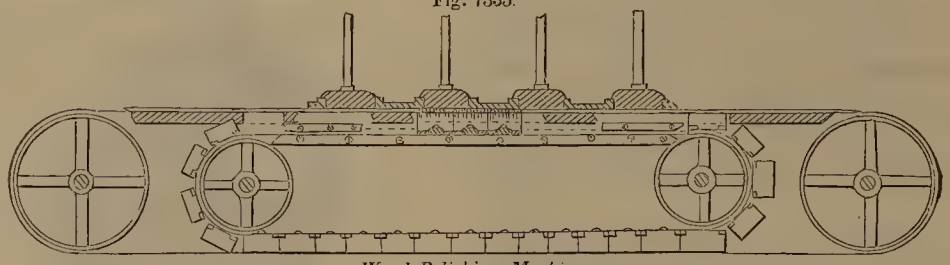
In the chemical treatment of wood for paper, solutions of the fixed alkalies at high pressure and at 300° Fah. are employed. Or a strong solution of hydrochloric acid, to which a small quantity of nitric acid has been added. Or a dilute solution of hydrochloric acid at a boiling temperature, followed by washing, draining, grinding, digesting in a solution of ammonia, and bleaching by chloride of lime.

Bachet and Machard's process is to digest the billets of wood in a boiling solution of hydrochloric acid, withdraw the liquid, saturate with carbonate of lime, ferment and distill; this utilizes the substances which incrust the fibers of wood. The wood is then crushed, strained, and made into paper, which is rolled on mandrels and partially bleached by exposure to chlorine gas, or fully so by treatment with lime-water, carbonate of soda, and chloride of lime, successively.

In Lee's process (English) the wooden chips are digested in a solution of caustic soda at 220° Fah

Koop's English patent, 1802, describes the use of straw, hay,

Fig. 7335.



*Wood-Polishing Machine.*

thistles, hemp, and flax refuse, wood, and bark, for making printing and other paper. He digested the materials in a solution of quicklime and river-water, and then macerated for several days with frequent agitation; then washed. This was repeated; the mass was then treated with soda or potash. Fermentation was sometimes allowed to assist in the disintegration of the fiber. The plant stuff was cut by machinery to a length of two inches; wood was reduced to shavings before treatment.

The process pursued at the Manyunk mills, Philadelphia, is about as follows: —

The poplar-wood is made into chips by choppers, which reduce from 35 to 40 cords of wood per day. The chips are carried by elevators to the boilers, where they are digested in alkali for five or six hours. The mass is dropped from the boilers in vats and lixiviated with water to remove the chemicals. Ten of these boilers turn out 300,000 pounds per day. The pulp is then bleached, diluted with water to make it work in the cylinder paper-machine, which brings it into convenient transportable form. These sheets of dried pulp are taken to other mills and mixed with cotton pulp or straw, in such proportions as may be required for the purpose intended, — book or newspaper work.

See PULP-BOILERS, Figs. 4003 - 4013; PULP-DRESSER, Fig. 4014; PULP-GRINDER, Figs. 4015 - 4019. See also WOOD-GRINDER.

In the manufacture of paper from bamboo, early in the month of June the canes are cut into pieces from 5 to 7 feet long, and placed in a pit which is supplied with water. After soaking for several weeks, the canes are beaten with mallets, in order to remove the thick bark and green skin. The remaining filaments, resembling a fine sort of hemp, are treated with lime and water, raised to a certain temperature. After remaining in this bath for about a week, the filaments are removed, washed with cold water, passed through a lye made of wood-ashes, and then placed in a boiler. This process is repeated until the material begins to grow putrid, when it is transferred to a mortar and pounded into pulp, by means of water-power, after which the mass is treated with bleaching-powder. The pulp thus prepared is made by hand into sheets of various thickness, by means of a web of silk tissue within a light frame, on to which the workman places the required quantity of pulp. When the water has run off from the corners of the frame, he turns the sheet over on to a large table, when it is pressed. Each sheet is afterward raised and dried separately in a kiln built for that purpose.

Writing-paper is made from the finest part of the bamboo material. Another kind is made by mixing rice-straw with the bamboo fiber. A very strong paper, used for window-blinds and other articles, which, in this country, are generally constructed of woven substances, is made by mixing 60 per cent of the bark of a tree called *tchou* with 40 per cent of bamboo material. Another variety of strong paper is obtained from the bark of the *Morus papyrifera*, a paper mulberry. The same material, made from thinner pulp, is employed in the manufacture of umbrellas, fans, and fire-screens. Bark-paper, which is to be painted, is first passed through a solution of alum-water, to destroy the fine filaments which are commonly found on the upper side of the sheet as it lies in the silk tissue-frame; the lower side in contact with the tissue being much more smooth. For many uses, when only one color is required, the coloring material is added to the pulp. See also page 1606.

Paper is made in Siam from the root of a tree called the *ton koy*, four or five feet in length, and sold in bundles of 10,000 pieces for 25 cents. The roots are first soaked in fresh water, and then transferred to tanks with lime-water, where they are left for several days. They are then boiled in a peculiarly constructed pan, the lower part of which, exposed to the fire, is made of sheet-iron, while the upper part is of basket-work. After being well steamed in these vessels, it is taken out in small quantities and thoroughly hammered on a table. After this process a bundle of the fiber is thoroughly agitated in water until small feathery clumps swim about in the tub. The contents of the tub are poured through a sieve and the fiber caught on the meshes in tolerably uniform thickness. This uniformity is farther aided by rolling bamboo over it, and the sieve is then exposed to the sun until the mass is thoroughly dry. The sheets of paper prepared in this way depend in size upon the sieves. They are sometimes ½ yard wide and 2½ yards long. Two workmen can make twenty sheets in a day. No sizing is used, as the gelatine of the root is sufficient for that purpose. A better sort of paper is sold in sheets 12 to 18 inches long, and 4 to 5 inches wide. Writing is done with charcoal, or with pencils prepared of coal and lime.

**Wood-plan'ing Ma-chine'.** Bramah's English patent, 1802.

The planing-machine for wood long preceded that for metal. General Bentham's reciprocating planing-machine was invented in 1791; Bramah's transverse planer, in 1802. See PLANING-MACHINE, pages 1728, 1729.

**Wood-pol'ish-ing Ma-chine'.** Fig. 7335 shows a machine for polishing pencils, which are placed on an endless apron, that runs over a table. The ends of the pencils enter guide-notches in the blocks of an inner endless apron, running at a different speed from the former apron, so as to cause rotation in the pencils as they are carried forward beneath the polishing-blocks, which are reciprocated transversely as to the machine and lengthwise of the pencils. The blocks are coated with sand-paper of various degrees of fineness and depressed by springs.

**Wood, Pres-er-va'tion of.** Seasoned timber is but little liable to decay under the influence of a dry atmosphere, and will resist decomposition for an indefinite period, when kept totally submerged in the water. The piles of old London Bridge, driven 800 years before, were found to be in good condition when the new bridge was erected in 1829, and those which served as the foundation for Trajan's bridge over the Danube, A. D. 105, are said to be still visible at low stages of water.

Probably the oldest timber in the world which has been subjected to the use of man is that which is found in the ancient temples of Egypt. It is found as dowel-pins, in connection with stone-work which is known to be at least 4,000 years old. These dowels appear to be of tamarisk, or chittim-wood, of which the ark is said to have been constructed, — a sacred tree in ancient Egypt, and now very rarely found in the valley of the Nile.

When exposed to the combined action of heat, air, and moisture, however, the best seasoned and most durable timber soon decays, its albuminous matters becoming decomposed and evolving ammoniacal gases; the fibrous portions are then readily disintegrated. To remedy this it is necessary that the albumen should be coagulated, and that antiseptics should be introduced into the pores to replace those which the vital force of the wood itself eliminates from the earth and air while in a living state.

The processes of painting, or coating and carbonizing the exterior, to prevent access of air and moisture, have been known from the earliest ages; these, however useful they may be for many purposes, tend but to palliate the evil, and somewhat postpone the period of decay.

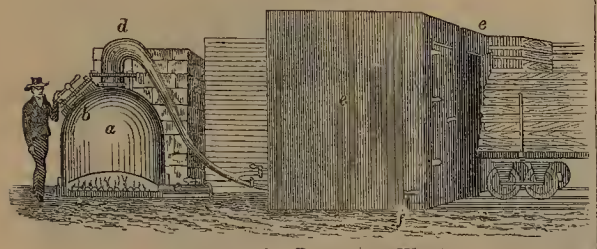
The methods, besides these, employed at present may be divided into two principal classes, — those in which the wood is saturated with the preservative material by immersion, and those in which the material is forced into the pores in a vaporiform state. The first of these processes appears to date back no farther than the last century; the latter is of still more recent introduction.

As early as 1740, Fagol, a Frenchman, experimented with solutions of alum, sulphate of iron, and other substances, in which he immersed the wood for several days.

In 1756, Haller recommended the use of vegetable oil for this purpose. Jackson, in 1767, proposed to employ a solution of sea-salt, to which sulphate of iron and magnesia, alum, lime, and potash, were to be added. Pallas, 1779, proposed to mineralize wood by immersion first in solution of copperas and afterward in milk of lime.

Dr. Hales recommended steeping in solution of sulphate of copper (blue vitriol), and coating with oil of tar; for which Dr. Fordyce substituted sulphate of iron; this was tried with good

Fig. 7336.




*Apparatus for Preserving Wood.*

results in the West Indies. Colouel Congreve, in 1784, proposed coating with creosote

Sir Samuel Bentham, among his other numerous inventions, patented a method of exhaustiug air from the pores, and then forcing in chemical agents.

Sir Humphry Davy suggested a solution of corrosive sublimate; this was subsequently used in the process of Kyan.

Other modes of treatment, as buryiug the timber in hot sand, steaming, and the application of water-proof coating of various kinds, were also tried with more or less success.

The processes and materials employed or proposed have been very numerous, and have formed the subject of many patents.

Amoug the substances which have at various times been the subject of patents are: —

| | |
|---|---|
| Acetate of copper. | Sulphuric acid. |
| Sulphate of copper. | Lime-water. |
| Sulphate of lime. | Potash and lime. |
| Sulphate of alumiua. | Silicate of potash. |
| Sulphate of soda. | Nitrate of potassa. |
| Sulphate of iron. | Arsenious acid. |
| Carbonate of soda. | Corrosive sublimate. |
| Carbonate of potassa. | Oil. |
| Carbonate of baryta. | Tallow. |
| Tar. | Rosiu. |
| Creosote. | Petroleum. |
| Smoke. | Pyrolignite of iron. |
| Chloride of sodium. | Refuse liquors of chloriue works. |
| Chloride of ziuc. | Mother water of marshes. |
| Sulphate of magnesia. | Metallic sulphurets, after decomposition by an acid or a metallic salt. |
| Sulphate of baryta. | |
| Phosphate of baryta. | |
| Borax. | |

In 1832, Kyan, in England, pateuted a method of preserving timber by imuersing it in a solution of bichloride of mercury (corrosive sublimate); the proportious are varied somewhat, generally about 2 parts of sublimate to 100 of water are employed. Large timbers are placed iu air-tight tauks, the air is exhausted, and the solutiou forced in under pressure.

Margary's process, 1837, consisted in immersing the wood in acetate or sulphate of copper.

Sir William Burnett, 1838, patented a process for saturating wood with a solution containing 1½ parts of chloride of zinc (white vitriol) to 100 parts water, forced into the pores of the wood, from which the air was exhausted, under a pressure of 125 to 150 pounds per square inch.

Bethel's patent (English, 1838). The wood is impregnated with oil of tar and other bituminous matters, eontaining creosote, and also with pyrolignite of iron, which holds more creosote in solution than any other watery menstruum. It is placed in close iron tanks, which are filled with the oil of pyrolignite; the air is then exhausted, and afterward more of the impregnating material is forced in, and a pressure of 100 to 150 pounds per square inch maintaiued for six or seven hours, when the wood will be found to have iucreased in weight from eight to twelve pouuds per cubic foot, and become thoroughly saturated.

Boucherie's process, 1840, is extensively employed in France. It consists in forcing sulphate of copper solution into the pores of the wood under the pressure of its own gravity. The timber is set on end and covered with a water-tight cap, into which the liquid, from a reservoir at a considerable elevation, is conducted by a flexible pipe. The sap is forced out at the lower end, and its place supplied by the solution, which consists of 1 part of the sulphate to 100 parts water.

Chloride of sodium, similarly introduced, renders the wood flexible when seasoned Earthy chlorides are employed for rendering it incombustible. In a similar way odors, resins, and coloring-matters may be introduced.

Baron Champy indicated a method of preserving wood by dipping while green in tallow, at 200° Fah.; the water and gases being expelled, the melted tallow penetrates the pores under atmospheric pressure.

Payen, employiug nearly the same process, substituted rosin for tallow.

Chapman's process consisted in a peculiar system of treatment with sulphate of iron.

Phosphate of baryta, formed within the fiber of wood, has been used as a preventive of decay. The wood is to be first steeped in a solution containing 7 per cent of the phosphate of soda. When dry it is again treated with a solution containing 13 per cent of chloride of barium.

Payne, 1842, used sulphate of iron (green copperas).

The wood is introduced into a cylindrical vessel, and steam admitted to expel the air; a portion of the sulphate solution is then injected to condense the steam and form a partial vacuum, which is completed by means of an air-pump. The remainder of the sulphate is allowed to flow in and a force-pump applied, by which it is forced into the pores of the wood. At the end of a few minutes the solution is withdrawn, steam is readmitted, and the wood similarly treated with muriate of lime; the reactions produce sulphate of lime and muriate of iron, which remain within the substance of the wood, rendering it much heavier and harder, and preventing the attacks of insects.

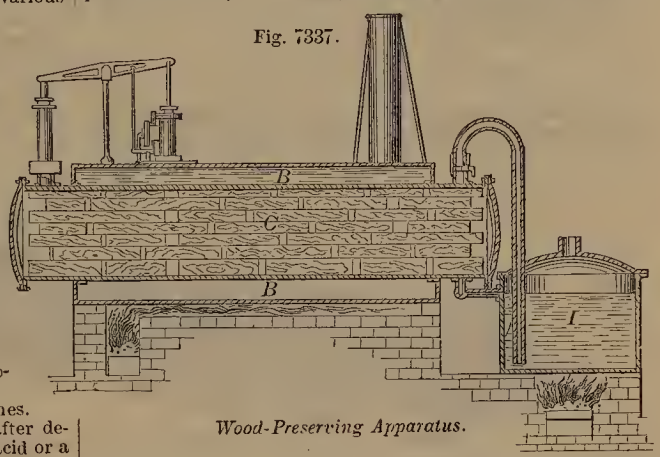
Soaking timber in lime-water has been recommended for preserving it from dry-rot and the effects of the weather; also, superficial carbonizatiou by a gas-flame or the flame of the heavy hydrocarbon oils.

Davis and Symington, in England, introduced a desiccating hot-blast to remove moisture.

Behr's patent embraces the employment of boiling solution of borax.

Szerelmey's patent: 1st, immersing wood in boiling solution of potash and lime, and treating it with cold dilute sulphuric acid;

Fig. 7337.




*Wood-Preserving Apparatus.*

and, 2d, coating it with compounds of petroleum, asphaltum, lime, zopissa, and sulphuric acid.

L. S. Robbins's method eousists in removing the surface-moisture from the wood by heat, and then saturatiug it with the vapors of coal-tar, rosiu, or other oleaginous substances.

Fig. 7336 illustrates a form of the apparatus employed. *a* is the retort in which the oleaginous material is heated; it is provided with a charging and man-hole *b*, a discharge-pipe *c* for removiug the residuum left after distillation, and pipes *d* connecting it with the chambers *e e*, where the wood to be treated is placed; these have closely fitting doors, and pipes *f* at bottom for withdrawing eondeused liquid.

The timber being placed in the chambers *e e*, and the retort partially filled with coal-tar, a heat of 212° to 250° Fah. is applied: this expels the surface-moisture from the wood, and it condenses within the chambers, whence it may be withdrawn through the pipes *f*. A greater degree of heat, 300° Fah. or upward, is then applied, causing the oleaginous vapors to permeate the wood until it is thoroughly saturated, and has become impervious to moisture.

In Heinemann's process, patented 1868, the wood is first boiled in a weak solution of carbonate of soda or other alkali, or dilute muriatic acid, until the liquid ceases to abstract color from the wood: the nitrogenous matter is thus ascertained to have been removed, and the wood, after drying, may be employed in situations where it will not be subjected to moisture. For railway ties, etc., it is farther treated by heating in close chambers with rosin and water, the combined steam and resinous vapor penetrate the wood, the latter remaining, while the former is expelled by cooling and sudden reheating. When it is desired to render the timber fire-proof, soluble glass may be substituted for the rosin.

Van Der Weyde employs a dilute solution of silicate of potash; after this has dried, one or two coats of a stronger solution of the same are given.

Blythe's process, said to have been employed with good results in France, consists in treating the timber with steam, intermixed with a proportion of hydrocarbon vapor. This softens it so that its form may be altered to a considerable extent by pressure; the form thus given is permanently retained. A gummy substance is formed in the pores, which in time becomes hard.

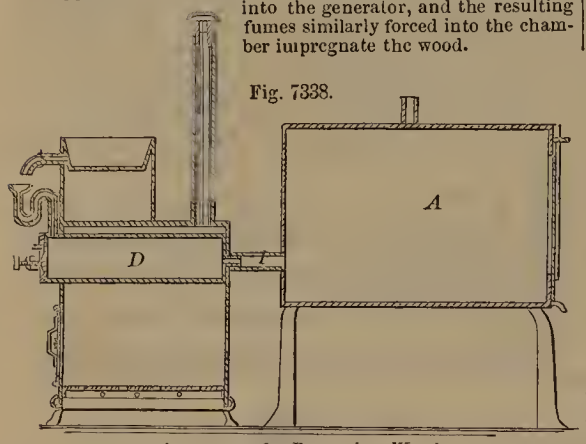
Several forms of apparatus have been devised for impregnating wood with the vapor of tar and other materials.

In Fig. 7337, the cylinder *C*, containing the wood, is within the annular boiler *B*, and is connected at one end with an air-

pump, and at the other with a boiler *I* containing tar, from which the paper is derived.

In Fig. 7338, heated air is driven from the generator *D* into the chamber *A*, containing the wood, the vapor escaping from the upper pipe. When the wood is dry, tar is introduced into the generator, and the resulting fumes similarly forced into the chamber impregnate the wood.

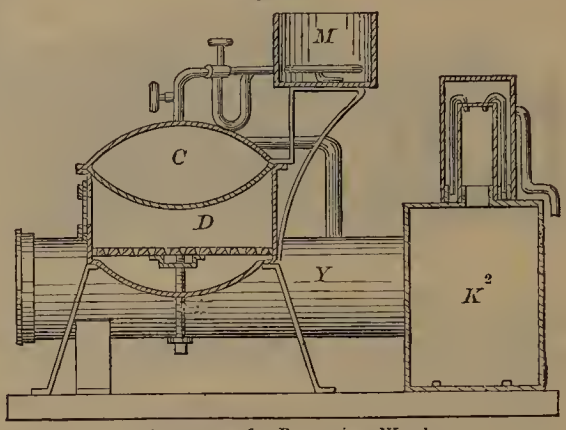
Fig. 7338.




*Apparatus for Preserving Wood.*

In Fig. 7339, steam and the products of combustion from the fire-chamber *D* are admitted into the chambers *Y* $K^2$ containing the wood; when the moisture is thus expelled, the wood is subjected to the vapor of oil, carbolic acid, or other antiseptic contained in a tank or tanks *M* and vaporized in the generator *C*.

Fig. 7339.

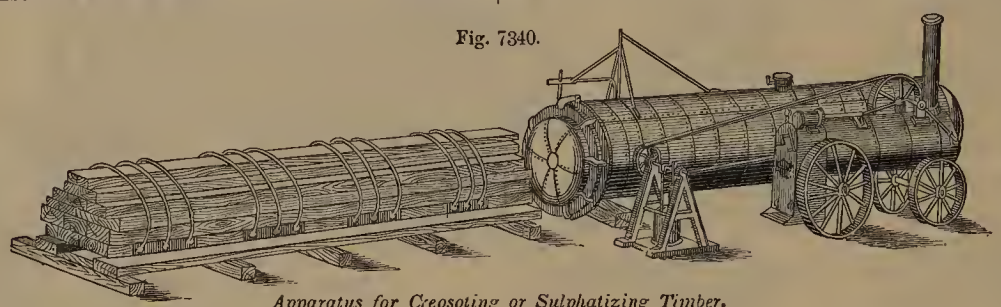



*Apparatus for Preserving Wood.*

Salt is extensively employed for preserving ship-timber.

Fig. 7340 illustrates an apparatus for preserving timber by one of the above-described or similar processes. The joists,

Fig. 7340.



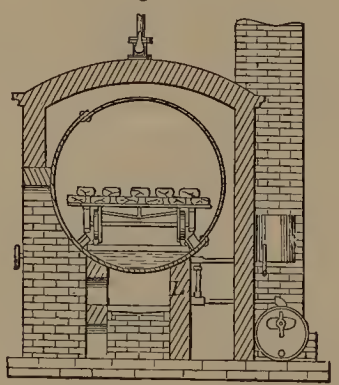
*Apparatus for Creosoting or Sulphatizing Timber.*

clamped into a pile of proper size, are introduced longitudinally within the cylinder, where they are to be dried and chemically treated.

In Voorhees and Custis's apparatus (Fig. 7341), the oleaginous or antiseptic vapors are generated in the chamber where the material to be treated is placed. This is surrounded by a cool-air passage, provided with devices for controlling the ingress and egress of the air.

A committee appointed by the Dutch Academy of Sciences to investigate means of protecting timber against the teredo, after a series of experiments, consisting in coating the wood

Fig. 7341.



*Apparatus for Preserving Wood.*

with various substances, as (1) a mixture of tallow, coal-tar, resin, sulphur, and pounded glass, applied warm; (2) paraffine varnish, obtained by dry distillation of peat; (3) coal-tar, alone and mixed with sulphuric acid; (4) paint, composed of linseed-oil, turpentine, chrome green, and verdigris, — reported that none of these materials nor carbonization prevented the ravages of the worm.

Impregnation with sulphates of copper or iron, acetate of lead, and with soluble glass and chloride of calcium, which, by reaction, formed silicate of lime, was found to be ineffectual.

The conclusion was arrived at, that coating with paint, or even metal, affords but temporary protection, as the young teredo will enter through the smallest abrasion. Poisonous salts are not fatal to the animal, as it does not feed upon the ligneous tissue which it perforates, and are liable to be washed out by the water. The density of the wood appears to afford no immunity from its attacks. Oil of creosote seems to be the only effectual preventative; piles saturated with this substance were unattacked after being submerged five years.

The committee did not test petroleum, nor does it appear to have tried other hydrocarbous or their derivatives.

The following United States patents may be consulted: —

| No. | Name and Year. |
|---|---|
| 4,560. | Von Schmidt, 1846. |
| 47,132. | Robbins, 1865. |
| 48,636. | Hamar, 1865. |
| 49,146. | Palmer, 1865. |
| 49,382. | Cooley *et al.*, 1865. |
| 52,046. | Holmquist, 1866. |
| 53,217. | Eddy, 1866. |
| 53,267. | Buell, 1866. |
| 54,194. | Myers, 1866. |
| 55,216. | Ransome, 1866. |
| 57,960. | Perry, 1866. |
| 58,203. | Benjamin, 1866. |
| 60,794. | Samuels, 1867. |
| 4,158. | Samuels (reissued), 1870. |
| 62,334. | Holmes, 1867. |
| 62,956. | Harvey, 1867. |
| 63,300. | Prindle, 1867. |
| 64,703. | Pustkutchen, 1867. |
| 65,545. | Constant *et al.*, 1867. |
| 67,104. | Clarke *et al.*, 1867. |
| 68,069. | Harding, 1867. |
| 69,260. | Seeley, 1867. |
| 70,761. | Taylor, 1867. |
| 73,246. | Harmyer, 1868. |
| 73,565. | Beer, 1868. |
| 77,777. | Spauldiug, 1868. |
| 78,514. | Calkins, 1868. |
| 84,733. | Cowling, 1868. |
| 86,808. | Bridge, 1869. |
| 87,226. | Voorhees *et al*, 1869. |
| 88,392. | Karmrodt *et al.*, 1869. |
| 91,848. | Hunt, 1869. |
| 94,204. | Heinnemann, 1869. |
| 94,626. | McNair, 1869. |
| 94,704. | Blanchard, 1869. |
| 94,869. | Clark, 1869. |
| 95,473. | Heinnemann, 1869. |
| 95,474. | Heinnemann, 1869. |
| 95,583. | Hayford *et al.*, 1869. |
| 99,186. | Haupt, 1870. |
| 100,380. | Day, 1870. |
| 100,608. | De Smedt, 1870. |
| 101,012. | Hayford, 1870. |
| 101,691. | Williams, 1870. |
| 102,725. | Stevens, 1870. |
| 103,105. | Van Camp *et al.*, 1870. |
| 104,916. | Tripler, 1870. |
| 104,917. | Tripler, 1870. |
| 4,837. | Tripler (reissued), 1872. |
| 4,838. | Tripler (reissued), 1872. |
| 106,625 | Sheldon, 1870. |
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| 107,854. | Beach, 1870. |
| 4,384. | Beach (reissued), 1871. |
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| 108,661. | Westman, 1870. |
| 109,872. | Cresson, 1870. |
| 109,873. | Cresson, 1870. |
| 112,136. | Fowler, 1871. |

| No. | Name and Year. |
|---|---|
| 113,338. | Pelton, 1871. |
| 113,706. | Thomas, 1871. |
| 115,784. | Tait, 1871. |
| 115,931. | Brown, 1871. |
| 116,274. | Constant *et al.*, 1871. |
| 118,245. | Jones, 1871. |
| 118,528. | Gyles, 1871. |
| 120,009. | Sutpheu, 1871. |
| 123,009. | Fawcett *et al.*, 1872. |
| 123,467. | Fuechtwanger, 1872. |
| 124,080. | Peltou, 1872. |
| 124,358. | Holmes, 1872. |
| 124,402. | Waterbury, 1872. |
| 124,419. | Cole, 1872. |
| 124,420. | Cole, 1872. |
| 127,482. | Hayford, 1872. |
| 128,387. | Gyles, 1872. |

**Wood-saw.** See SAW; and for varieties, see list on page 2035.

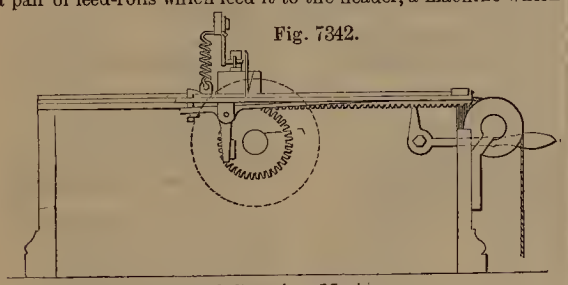
**Wood-scrap'ing Ma-chine'.** Fig. 7342 is a machine for scraping the surface of wood or veneer. The stuff to be smoothed is laid on the carriage, secured by a clamp, and carried forward by machinery beneath the scraper. When a dog comes in contact with a lever, the pinion falls out of gear, and the carriage is free to be drawn back for the next operation.

**Wood-screw.** A metallic screw for carpenters' and joiners' use in securing pieces of work together. A *wooden* screw, which is *one made of wood*, is used in clamps, carpenter's benches, bedstead-rails, etc.

While there are many machines for this purpose, and several variations in the order of the process, the following may answer, in a general way: —

The wire is placed upon a reel, and the end inserted between a pair of feed-rolls which feed it to the header, a machine which

Fig. 7342.



*Wood-Scraping Machine.*

cuts the wire into the lengths to which it is gaged, and sets up the heads, which is done by pressing the end of the wire into a die. The screw at this stage is called a *blank*. The next process is that of cleaning the blanks from grease and dirt; they are placed in iron boxes filled with white-pine sawdust. These boxes are revolved rapidly, and the friction of the blanks against each other and the particles of the sawdust cleanses them perfectly and makes them bright. After cleaning, the blanks are placed in the hoppers of the shaving-machines, from which they are picked up by claws, inserted in spindles which turn the heads, cut the slots, and eject them into boxes. They are then placed in the hoppers of the finishing-machines, which automatically complete the process of pointing and cutting the thread.

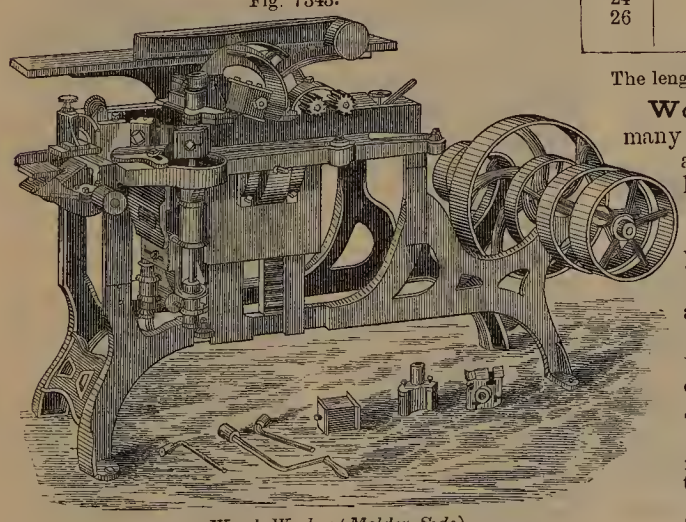
Wood-screws are classed by the length in inches, and by the number, which indicates the size of the wire, or body of the screw.

The following table of dimensions, derived from measurements of the screws made by the New England Screw Company, at Providence, R. I., will be found convenient for reference: —

| No. | Diameter of body. | Head. | | Number of threads to 1 inch. |
|---|---|---|---|---|
| | | Diameter. | Thickness. | |
| | In. | In. | In. | |
| 3 | 0.10 | 0.20 | 0.06 | 24 |
| 4 | .11 | .22 | .065 | 24 |
| 5 | .13 | .26 | .075 | 20 |
| 6 | .15 | .30 | .08 | 20 |
| 7 | .16 | .32 | .085 | 18 |
| 8 | .17 | .34 | .09 | 14 |
| 9 | .19 | .38 | .095 | 13½ |
| 10 | .20 | .40 | .10 | 13 |
| 11 | .21 | .42 | .11 | 12 |
| 12 | .22 | .44 | .12 | 11 |
| 13 | .23 | .46 | .13 | 11 |
| 14 | .24 | .48 | .14 | 10 |
| 15 | .25 | .50 | .15 | 10 |
| 16 | .26 | .52 | .16 | 9½ |
| 17 | .27 | .54 | .17 | 9 |
| 18 | .28 | .56 | .18 | 8½ |
| 20 | .30 | .60 | .20 | 8 |
| 21 | .32 | .64 | .21 | 8 |
| 22 | .35 | .70 | .22 | 7½ |
| 24 | .38 | .76 | .24 | 7 |
| 26 | .40 | .80 | .26 | 7 |

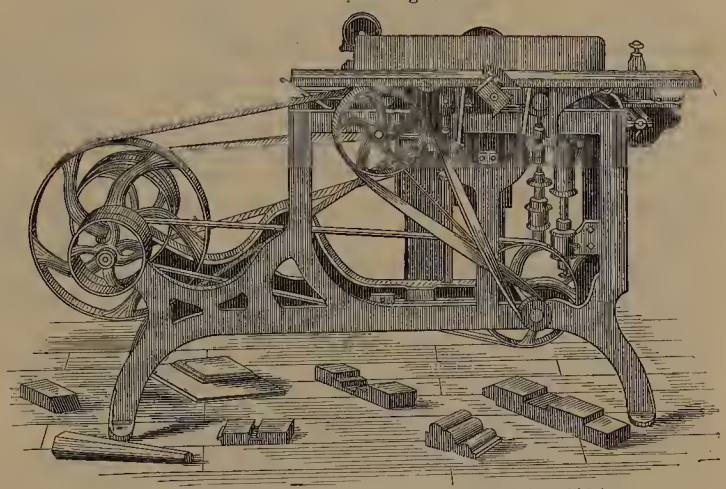
The length of thread cut is two thirds the length of the screw.

Fig. 7343.



*Wood-Worker (Molder Side).*

Fig. 7344.



*Wood-Worker (Squaring-up and Facing Side).*

**Wood-split'ting Ma-chine'.** One used in many trades, and differing according to the size and purpose of the material. For shoe-pegs, kindling, firewood, etc.

**Wood-still.** See STILL; TURPENTINE.

**Wood-stove.** One specially adapted for burning wood. See STOVE.

**Wood-turn'ing Lathe.** See LATHE, and list under that head.

**Wood-work'er.** A machine-tool having various attachments and adjustments for different kinds of work. Also called a JOINER (which see).

Fig. 7343 is the machine, showing *molding* attachment to work four sides. The squaring-up and facing tables are on the other side.

Fig. 7344 shows the *squaring-up* and *facing-table* side.

**Wood-work'ing Ma-chine'.** First in the list of inventors of wood-working machinery is General Sir Samuel Bentham, the brother of Jeremy, the political economist. While making a tour of Europe to observe the modes of shipbuilding, and on the occasion of a visit to Russia, he contrived the first planing-machine for wood. Working in the interest of the British Admiralty, he afterward devoted himself to the invention and construction of labor-saving machines.

Professor Willis states that General Bentham's house was converted into and formed the first manufactory of wood-working machines, "including planing, molding, rabbeting, grooving, mortising, and sawing, both in coarse and fine work, in curved, winding, and transverse directions, and shaping wood in complicated forms." The bills for these machines, presented to the Admiralty, specify lathes, saws, machines for cutting tenons, for boring, also for boring-bits and squaring-tools, and "many other machines for different kinds of work." One set of machines was for block-making; in this he was joined by a gentleman of equal talent, Mr. Brunel. (See BLOCK-MAKING MACHINES.) Mr. Brunel was allowed as a premium for his inventions the estimated saving over one year's hand labor, equal to $80,000. General Bentham received $100,000 for the machines furnished. Among the machines made by Bentham previous to 1800 may be enumerated: —

Planing-machine.
Molding-machine.
Circular saw.
Segmental circular saw.
Dovetailing-machines, with conical cutters.
Wave-molding machine, with undulating carriage.
Crown and cylinder saws.
Lathes, with slide-rests.
Planing-machines, with cutter-heads, to dress both sides, and with rack-feed.
Mortising-machines, reciprocating and rotary.
Mortising-machines, with pivoted tables.
Segment sawing-machines, with radius arms.
Boring-machines, with annular bits.
Saws, with tracer-guides, for irregular forms.
Bevel-saws.
Curvilinear saws.
Taper-gage, for sawing-machine.
Grooving-machines.
Machines for grinding saw-blades.
Double-grooving saws.
Rabbeting-machines.
Sectional cutter, for planing-machines.
Gage-lathe, with slide-rest.
Screw-thread machines, with rotary cutters.

The *circular* saw is described in Miller's English patent, No. 1152, of 1777.

Hatton patented a planing-machine in England in 1776, but the description is vague.

**Wood-work'ing Tools and Ma-chines'.** See under the following heads: —

Addice.
Adze.
Auger (varieties; see AUGER).
Axe (varieties; see AXE).
Bark-cutting machine.
Bark-grinding machine.
Bark-planing machine.
Bench.
Bench-clamp.
Bench-hook.
Bench-screw.
Bench-strip.
Bench-vise.
Bending-wood.
Bit. Boring (varieties; see BIT).
Blind-slat cutter.
Blind-slat machine.
Blind-slat tenoning-machine.
Blind-stile making machine.
Blind-stile mortising-machine.
Blind-stile piercing-machine.
Blind-stile spacing-machine.
Blind-stile tenoning machine.
Blind-wiring machine.
Block-letter cutting-machine.
Block-making machine.
Bois-durci.
Bolt-sawing machine.
Boring-bit.
Boring and tenoning machine.
Bowls. Machine for making
Box and tap.
Box-making machine.
Box-setting machine.
Box-turning machine.
Brace.
Brad-awl.
Break-iron.
Broadaxe.
Brog.
Broom-handle.
Broom-handle machine.
Broom-splint machine.
Brush-back machine.
Brush-handle machine.
Buhl.
Bung-cutter.
Burnetizing.
Butter.
Butting-machine
Button-lathe.
Button-machine.
Calipers.
Calking-tools.
Cane-polishing machine.
Cane-splitting machine.
Carpenter's gage.
Carpenter's level.
Carpenter's plow.
Carpenter's rule.
Carpenter's tools and appliances (see CARPENTRY).
Carving-machine.
Cauking.
Caul.
Chair-back dressing-machine.
Chair-back rounding-machine.
Chair-back sawing-machine.
Chair-seat boring-machine.
Chair-seat planing-machine.
Chipping-machine.
Chisel (varieties; see CHISEL).
Chit.
Clamp.
Clapboards. Machine for gaging
Clapboards. Machine for making
Clapboards. Machine for planing
Clothes-pins. Machine for making
Cocking.
Cork-cutting machine.
Cork-making machinery.
Cutter.
Cutter-head.
Cutter-stock.
Deal-frame.
Dog. Saw-mill
Dovetail-cutter.
Dovetail-machine.
Dovetail-making machine.
Dovetail-marker.
Dowel-making machine.
Drawing-knife.
Drums, etc. Machine for making
Drunken cutter.
Dyewood-cutting machine.
Eave-troughs. Machine for making
Edger.
Edging-machine.
Edging-saw.
Embossing wood.
Felloe-beuding machine.
Felloe-boring machine.
Felloe-dresser.
Felloe-planing machine.
Felloe-sawing machine.
Files (varieties; see FILE).
Frame-making machine.
Fret-saw machine.
Fret-work.
Frizzing-machine.
Gage (varieties; see GAGE).
Gimlet.
Gouge.
Gunstock-making machine.
Gutters, wooden. Machine for making
Hammer (varieties; see HAMMER).
Handle-making machine.
Hand-mortising machine.
Hatchet.
Head-block for saw-mills.
Hollow auger.
Hollow-mandrel lathe.
Hoop-bending machine.
Hoop-cutting machine.
Hoop-dressing machine.
Hoop-sawing machine.
Hoop-splitting machine.
Hub-borer.
Hub-boxes. Machine for setting in
Hub-centering machine.
Hub-mortising machine.
Hub-turning machine.
Joiner.
Kerfing-machine.
Kindling-wood machine.
Lag-machine.
Last-cutting machine.
Last-making machine.
Last-polishing machine.
Last-turning machine.
Lath-cutter.
Lathe (varieties; see LATHE).
Lath-sawing machine.
Mallet.
Matches. Machinery for making
Match-frame.
Matching-machine.
Match-splint machine.
Miter-box.
Molding-machine.
Molding-mill.
Mortise-chisel.
Mortising-mill.
Nail-extractor.
Nulled work.
Oar-making machinery.
Pail-lathe.
Palm-leaf splitting-machine.
Panel-making machine.
Peg-making machine.
Picket-pointer.
Pin-making machinery.
Pin-tool.
Plane (varieties; see PLANE).
Plane-bit.
Plane-stocks. Machinery for making
Planer and matcher.
Planing-machine.
Planking-clamp.
Planking-screw.
Plow.
Plow-handles. Machinery for making
Plug-machine.
Pointing-machine.
Preserving wood.
Press-work.
Rabbeting-machine.
Rasp.
Rattan-cutting machine.
Rattan-dressing machine.
Rattan-polishing machine.
Rattan-reducing machine.
Rattan-slitting machine.
Rattan-splitting machine.
Rattan-stripping machine.
Riving-machine.
Rod, pin, and dowel machine.
Rossing.
Rossing-machine.
Rule.
Sand-paper holder.
Sand-papering holder.
Sash-bar machine.
Sash-boring machine.
Sash-chisel.
Sash-mortising machine.
Sash-planing machine.
Sash-sticking machine.
Saw (varieties; see SAW).
Sawdust-carrier.
Sawing-machine.
Saw-mill feed-devices.
Saw-mill gate.
Saw-plank feeder.
Scale-board.
Scorer.
Scorper.
Scraper-steel.
Screw.
Screw box.
Screw-cutting machine. Wood
Screw-driver.
Scribe-awl.
Scribing-iron.
Scroll-sawing machine.
Shaving-horse.
Shavings for stuffing. Machine for making
Shingle-jointing machine.
Shingle-machine.
Shingle-planing machine.
Shingle-riving machine.
Shingle-sawing machine.
Shive-cutting machine.
Shoe-peg making machinery.
Shoe-sole making machinery.
Shooting-board.
Skewer-machine.
Slab-grinder.
Slat-machine.
Slat-tenoning machine.
Snath-bending machine.
Snath-finishing machine.
Snath-rounding machine.
Spacing and boring machine.
Splint-cutter.
Splint-cutting machine.
Splint-plane.
Spoke-auger.
Spoke-driving bench.
Spoke-driving machine.
Spoke-gage.
Spoke-lathe.
Spoke-machine.
Spoke-planing machine.
Spoke-polishing machine.
Spoke-setter.
Spoke-shave.
Spoke-tenoning machine.
Spoke-turning machine.
Spool-making machinery.
Square.
Stave-bilging machine.
Stave-crozing machine.
Stave-dresser.
Stave-howeling machine.
Stave-jointer.
Stave-riving machine.
Stave sawing machine.
Stave-setter.
Tenoning-machine.

Timber-scribe.
Tooling.
Tray-making machine.
Trying-up machine.
Turning.
Veneer-cutting machine.
Veneer-hammer.
Veneer-planing machine.
Veneer-polishing machine.
Veneer-pressing machine.
Veneer-saw.
Veneer-sawing machine.
Veneer-straightening machine.
Vise.
Waney.
Washboards. Machine for making
Whalebone. Machine for working
Wheelwright's machine.
Willow-peeler.
Wiring blind-slats.
Withe-twisting machine.
Wood-bending machine.
Wood-boring machine.
Wood-bundling machine.
Wood-carving machine.
Wood-embossing machine.
Wooden gear. Machine for cutting
Wooden pipe.
Wooden ware. Machine for making
Wooden wedges. Machine for making
Wood-grinder.
Wood-planing machine.
Wood-polishing machine.
Wood-slivering machine.
Wood-splitting machine.

List of factory-machines: —

Planing and matching machine.
Surface-planer (surfacing-machine).
Combination-planer.
Clapboard planer and jointer.
Molding-machine.
Sash and molding machine.
Molding and dovetailing machine.
Shaper and edge-molder.
Shaping-machine.
Tenoning-machine.
Blind slat tenoning-machine.
Mortising-machine.
Car boring and mortising machine.
Hub boring and mortising machine.
Chair boring and mortising machine.
Blind-stile boring and mortising machine.
Buzz-planer.
Saw-table.
Circular-saw bench.
Sharpening-machine.
Saw-gage.
Sawing-machine.
Scroll-saw.
Band-saw.
Re-sawing machine.
Saw-arbor.
Spoke-lathe.
Spoke-planer.
Spoke and axe-handle lathe combined.
Spoke-throating machine.
Spoke facing and jointing machine.
Spoke-tenoning machine.
Rim-boring, doweling, and felly-jointing machine.
Spoke-polishing machine.
Felly-rounding machine.
Felly-planer.
Wheel-gage.
Wheel-screwing machine.
Hub boring and capping machine.
Rod, pin, and dowel machine.
Boring-machine car.
Boring-machine for agricultural implements.
Boring-machine chair.
Boring-machine furniture.
Blind-stile spacing and boring machine.
Matching-cutter.
Matcher-head.
Wood-turning lathe.
Blind-wiring machine.
Miter-machine.
Side-planing and jointing machine.
Butting-machine.
Dovetailing-machine.
Panel-raiser.
Blind-slat crimping-machine.
Door-clamp.
Knife-grinder.
Jointing-iron.
Barrel-machine.
Clothes-pin machine.
Match-machine.
Tub-machine.

**Woof.** (*Loom.*) The *weft* or *filling* of cloth, carried by the *shuttle* and laid in the *shed*. Also known as the *shoot*, or *tram*.

**Wool.** 1. The fleece of the sheep. See articles following.

2. A slag of iron blown by steam into a fibrous form. Known as *slag-wool*, or *silicate cotton*. See page 2198.

It is used as a clothing for steam-boilers and steam-pipes, to prevent loss of heat. A blast of steam, water, or air is forced into the stream of viscous slag as it runs from the furnace, when it assumes a fibrous form and appearance, somewhat similar to that of spun-glass.

**Wool-bun'dling Ma-chine'.** See WOOL-PACKER; FLEECE-FOLDER.

**Wool-bur'ring Ma-chine'.** A machine for picking the burs from wool. A *wool-picker*. See BURRING-MACHINE, Fig. 993.

**Wool-clean'er.** A machine for cleaning dust, burs, and other foreign matters from wool.

The material is placed in the feed-box, and carried forward by the endless apron on one side thereof, to the toothed cylinder at the bottom of the box. It is taken from the cylinder by the toothed beaters, and deposited upon the endless apron, by which it is carried to a second beating-cylinder, which throws it upon an apron by which it is carried to the pressure rolls. The sheet is then coiled upon a cylinder, the layers being separated by a cloth, and is retained thereon until fed to the carding-machine. See also WOOL-PICKER, and Fig. 993, page 412.

Wool is also cleaned by treatment in a chamber with petroleum, or with sulphide of carbon; see Fig. 3378. Also Robbins's patent, No. 75,980, March 24, 1868.

**Wool-comb'ing.** Said to have been invented by Bishop Blaize, who gave the name to St. Blazy, a village of Cornwall. He was bishop of Sebastia, in Armenia, and was decapitated in the Diocletian persecution, in 289. Processions in his honor are still celebrated in some parts of England, on the 3d of February.

For early English patents, see Cartwright, 1790; Wright and Hawksley, 1793; Toplis, 1793.

**Wool-comb'ing Ma-chine'.**

Lister's (English patent) circular machine is for separating the long from the short fibers of the wool. It is specially designed for long wool. The long fibers are also laid in regular order, so that they can be readily spun into yarn. Lister's apparatus clears the long fibers by drawing them through a series of teeth by means of a nipper. A pair of jaws seizes a mouthful of wool, and conveys it into a carrier, which, in its turn, deposits upon the comb a brush, pressing it down on the teeth to a proper depth. Having cleared one end of the staple, it transfers the uncleared end to the rotating comb, from which it is extracted by drawing-rollers. The *noil*, or short portion of the wool, is left in the comb, and is removed by another set of drawing-rollers. The long, cleared wool is delivered in a continuous sliver from the machine at one point, the *noil* being passed away at another. See COMBING-MACHINE.

Noble's machine is for combing short wool. It separates the long fibers from the *noil* by means of two circular separating-combs. These combs work together, and at the point of junction the wool is placed on their teeth. As they travel apart from each other, the fibers are cleared, and each comb presents a cleared fringe, which is drawn off in a sliver by drawing-rollers; the *noil* being passed away into a receptacle.

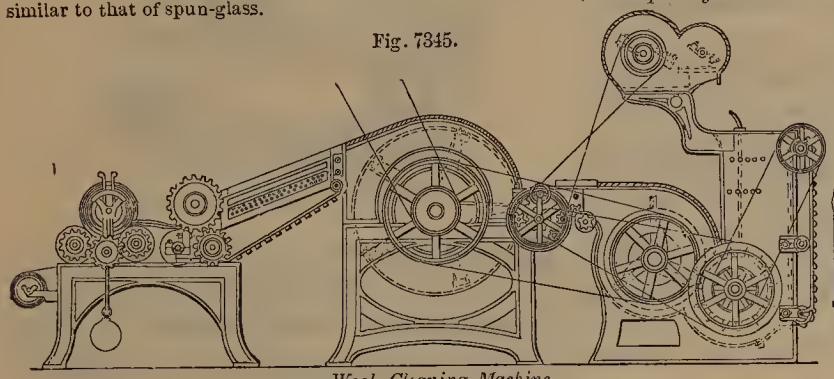
**Wool'der.** 1. (*Nautical.*) A stick used for tightly winding a rope round another object, as in *fishing a spar*. A *woolding-stick*. The action is analogous to *serving*.

2. (*Rope-making.*) One of the handles of the *top*, which occupies the angles of the strands, in laying up strands into ropes or ropes into hawsers, and which confines the twist, receding before it at the rate necessary to give the required hardness of twist.

**Wool'ding.** Wrapping. As of the yarn in serving a rope. A wrapping of hemp or yarn around a piston or plunger, acting as a packing.

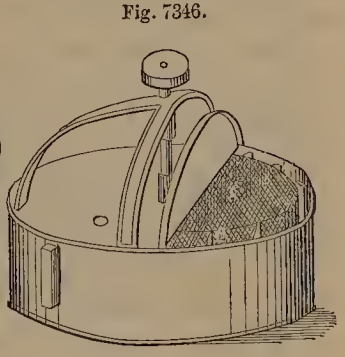
A wrapping of rope or cord around a splice, scarf, or a *sprung* mast.

Fig. 7345.



*Wool-Cleaning Machine.*

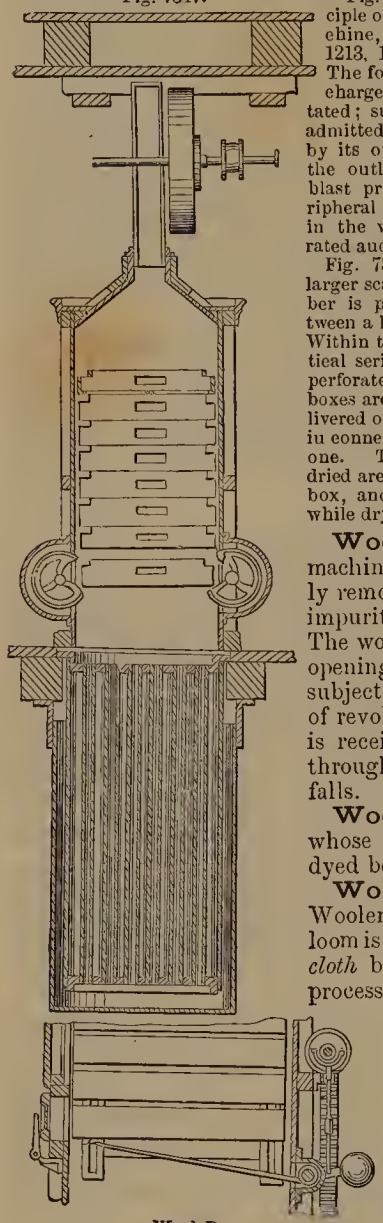
Fig. 7346.



*Dryer for Wool, etc.*

**Wool-dry'er.** A machine for removing the moisture from wool after washing, dyeing, or what not.

Fig. 7347.



*Wool-Dryer.*

Fig. 7436 is on the principle of the centrifugal machine, illustrated at Figs. 1213, 1214, and elsewhere. The foraminous cylinder is charged with wool and rotated; superheated steam is admitted above and ejected by its own pressure toward the outlet, assisted by the blast produced by the peripheral fans. The moisture in the wool is thus evaporated and removed.

Fig. 7317 is on a much larger scale. A drying-chamber is placed vertically between a heater and a blower. Within the chamber is a vertical series of boxes having perforated bottoms. These boxes are supported and delivered one at a time by cams in connection with the lower one. The matters to be dried are placed in the upper box, and gradually descend while drying.

**Wool-dust'er.** A machine for mechanically removing the coarser impurities from wool. The wool is fed into an opening at one end and subjected to the action of revolving beaters; it is received on a grate, through which the dirt falls.

**Wool-dyed.** Cloth whose fiber has been dyed before weaving.

**Wool'en Cloth.** Woolen cloth from the loom is made into *broadcloth* by a succession of processes: —

*Scoured* in soapy water, to remove grease.

*Tented*, or stretched on tenter-hooks to dry in the open air.

*Dyed*, unless it was wool-dyed before spinning.

*Burled*, or freed from irregular threads or hairs.

*Fulled*, to cause the fibers to interlace and become felted among each other, strengthening, condensing, and lessening the area of the fabric.

*Teaseled;* teasels, or wire brushes, in imitation of them, are made to bear forcibly upon the cloth as it passes in front of them, raising a nap thereon.

*Sheared;* the nap is reduced to an even length and smooth surface by shears, cutter, or fire.

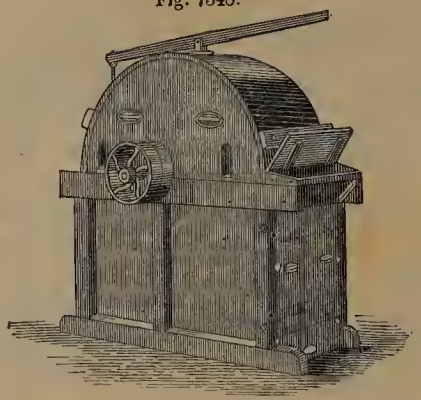
**Wool'en Man'u-fac'ture.** The treatment of wool is according to its staple, *long* or *short*, *combing* or *carding* wool; producing *worsted* or *woolens*.

The wool of England has always been celebrated; and even in the times of the Romans, a manufacture of woolen cloths was established at Winchester, for the use of the emperors.

The processes, in brief, are about as follows, each being described under its alphabetical arrangement: —

1. *Sorting*, as to fineness, softness, strength, color, cleanness, and weight; by which the various qualities of wool are placed together to avoid unevenness in the working and the fabric.
2. *Scouring;* washing in alkaline liquor, to remove *suint* and grease; followed by clean water.
3. *Dyeing.*
4. *Willowing*, or *deviling;* to loosen out the locks and bunches.

Fig. 7348.



*Wool-Duster.*

5. *Picking* (also known as *moting*, i. e. removing *motes*), or *burring;* to remove burs and other impurities.
6. *Oiling;* to prevent felting of the fibers in the subsequent operations.
7. *Scribbling;* a preliminary carding, to disentangle the fibers.
8. *Carding;* to form the wool into a *fleece*, *slivers*, *rolls*, or *rovings*, as the case may be.
9. *Slubbing;* to join the rovings in lengths.
10. *Drawing* and *spinning;* to attenuate the rovings and give the twist.
11. *Spooling;* winding on bobbins.
12. *Weaving;* to form cloth.
13. *Fulling;* to compact and felt the cloth.
14. *Teazeling;* to draw out a nap.
15. *Shearing;* to cut the nap to an even length.
16. *Pressing* between hot plates, to give glossiness.
17. *Brushing.*

For specific list of appliances in the treatment and manufacture of wool and other fiber, see COTTON, FLAX, WOOL, HEMP, etc., appliances.

The Argali, or *Ovis ammon* (Linn.), is supposed to be the progenitor of the stock of the domestic sheep. The steppes of Central Asia are its home, and thence it has spread. Among the bones of quadrupeds found in ancient caves throughout Europe, those of the sheep are not noted by Cuvier, Buckland, or De la Beche. We read in Pliny, Varro, and Columella of breeds of sheep of gray, brown, russet, black, and golden colors.

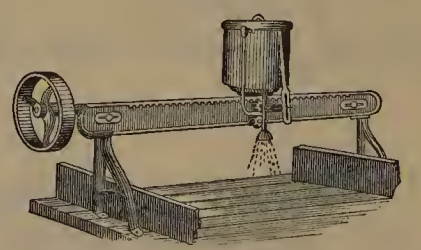
The spinning of wool was well known in the time of Moses, and was practiced among the Egyptians, Phœnicians, Greeks, and Romans at early periods of their respective histories.

The Romans are believed to have introduced the art into Britain, and to have had a wool factory for the supply of the Roman army in Britain, at Winchester.

Sheep are mentioned in an English public document of 712, in which their price is fixed at one shilling. The mother of the renowned Alfred the Great was skillful in the spinning of wool, and instructed her daughters in the art.

"Mr. John Coxetter of Greenham Mills, Newbury, had two Scoteh Southdown sheep shorn at his factory, at exactly five o'clock in the morning, from the wool of which, after passing its various processes, a complete damson-colored coat was made, and worn by Sir John Throckmorton, at a quarter past six in the evening, being 2¾ hours within the time allotted, for a wager of 1,000 guineas. The sheep were roasted whole, and a sumptuous dinner given by Mr. Coxetter." — *Old English paper.*

Fig. 7349.



*Wool-Oiler for Carding-Machine.*

**Woolff's En'gine.** A compound steam-engine, so called from its inventor's name. It has two cylinders of different diameter, the eduction-passage of the smaller cylinder communicating with the steam-passages of the other; high-pressure steam being used in the small cylinder, and made to act expan-

sively in the large one, the steam being afterward condensed in the usual manner.

**Wool-oil'er.** (*Woolen Manufacture.*) A device for attachment to the first breaker over the feed-apron, and immediately in front of the feed-rolls of the carding-machine.

The reservoir contains oil or composition, and, by means of a rack and pinion, is traversed back and forth over the wool as it enters the card; the oil, passing through a tube provided with revolving rocks, is distributed upon the wool by a rose-nozzle. When the card is stopped, the cocks cease to revolve, and the supply is cut off. The flow is regulated by an air-tube with a stop-cock, which enters near the top of the reservoir.

In Fig. 7350, the oil from the reservoirs flows into the perforated pipe, and drops into the inner side of the gauze cylinder. The wool is carried beneath the cylinder by the endless apron, and the oil is pressed into the wool by the cylinder.

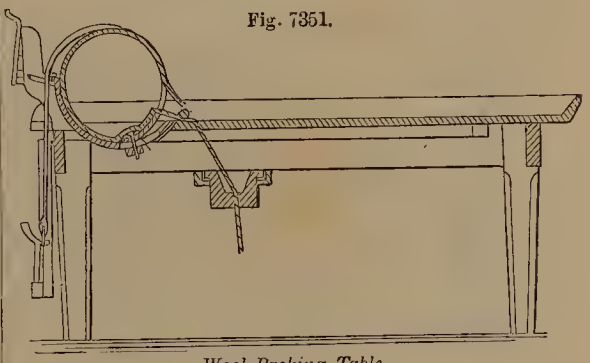
Fig. 7350.

*Wool-Oiler.*

**Wool-pack'er.** A machine for compressing and tying fleeces. There are several forms.

In Fig. 7351, the tie-cords are hitched to the catches at the edge of the concave bed, and pass under the wool and through the slots of the apron and holes in the bed beneath. The slotted apron is passed over the wool and attached to a treadle-lever, by which the wool is compressed, drawing it into the concave bed in position to be tied by the cord.

Fig. 7351.



*Wool-Packing Table.*

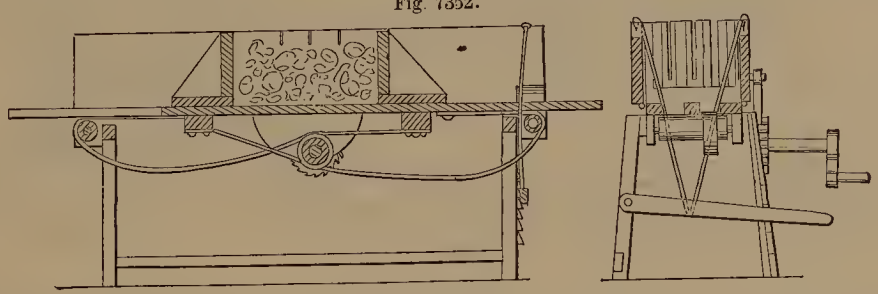
In Fig. 7352, the hinged sides are thrown up and held by cord connection to the treadle. The ends are then mutually advanced by strap connection to the drum beneath, which is rotated by a crank and sustained by a pawl.

In Fig. 7353, the folded fleece is laid on the packing-head; the two opposite long flaps are turned up, entering the pins of one into the holes in the other, the position being sustained by clamps. The short flaps are then raised, being locked by springs on the former. The head is raised by the treadle, the fleece tied both ways and then released. See also FLEECE-TYER, Fig. 2020.

**Wool-pick'er.** A machine for burring wool.

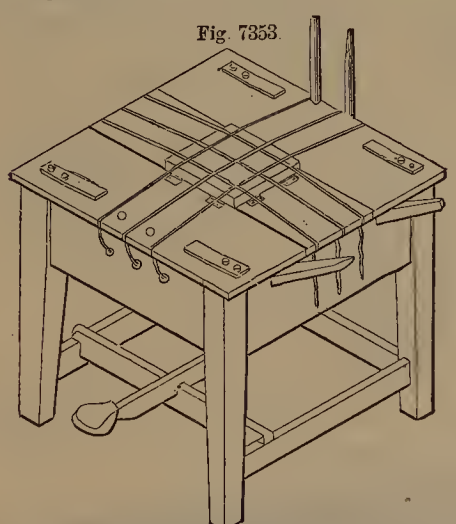
Fig. 7354 is on the principle of the saw-gin. The journal-boxes of the roller have a lateral adjustment so as to set the revolving brushes in such a position as to sweep the edges of the revolving blades on the cleansing cylinder, and clear them of adhering particles of wool. The floor is slotted to permit the dirt separated from the wool to pass down into the apartment below. See also WOOL-CLEANER; and BURRING-MACHINE, Fig. 993.

Fig. 7352.



*Wool-Press.*

Fig. 7353.



*Wool-Packing Table.*

**Wool-press.** See WOOL-PACKER.

**Wool-sort'ing.** In the systematic sorting of wool, the bales are opened, spread on a table, and sorted according to quality and condition. The technical names of the sorts are, *pick-locks, prince, choice, super, head, downright, seconds, fine-abb, coarse-abb, livery, short-coarse, breech.* These may not all be found in the same bale, but occur in the various grades and kinds.

**Wool-stock.** A heavy wooden hammer, used in fulling cloth.

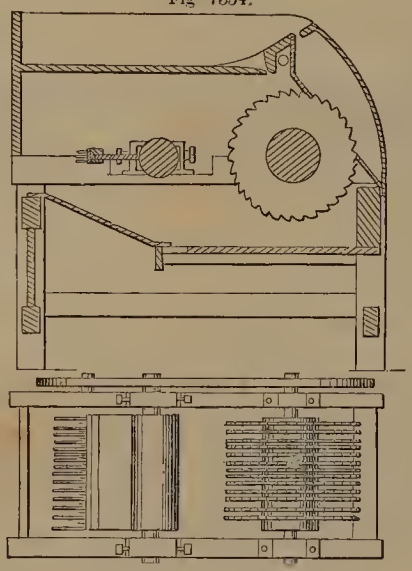
**Wool-ta'ble.** See WOOL-PACKER.

**Wool-wash'ing Ma-chine'.** A machine for cleansing fleece-wool in the factory.

McNaught's machine (United States patent, April 27, 1869) has a series of rakes for traversing the wool along the cistern to an inclined plane, up which it is moved by a cradle *g*, and delivered to a series of rollers, which convey it to the squeezers *i i*. The cradle *g* has a four-motioned action, down, forward, upward, and return; the teeth on its lower side catching the wool and drawing it up the incline.

In Clark's machine, 1865, the wool is conveyed into and out of the trough by endless aprons, and passed through the trough between two other endless aprons, under one of which is a bed of rollers, and over the upper of which a series of vertical beaters or stampers is arranged, one above each roller. These stampers are successively operated by a revolving shaft having thereon a set of lifters, spirally arranged. An inclined shelf under the rollers carries off the dirt as it is washed from the wool into an adjoining compartment, preventing its falling upon the lower portion of the lower apron. Provision is also made for picking the wool as discharged, by means of a revolv-

Fig. 7354.



*Wool-Picking Machine.*

ing cylinder, with radially advancing and receding teeth in conjunction with a set of stationary teeth.

In Murkland's machine, the wool is fed from an apron between a toothed roll and a concave, and caught by the spikes on the oscillating cylinder; the latter works above a perforated concave in the tank, and advances the wool toward the discharge end, where it is caught by a revolving picker and transferred by a belt to the squeeze rolls, which deliver it. Other wool-washers are like *centrifugal machines*, or resemble some of the numerous forms of *washing-machines*.

**Wool-work'ing.** See WOOLEN MANUFACTURE.

**Wootz.** A very superior quality of steel, made in the East Indies, and imported into America and Europe for superior edge-tools. It is used in the manufacture of the celebrated sword-blades of the East. Professor Faraday attributed its excellence to the presence of a small quantity of aluminium.

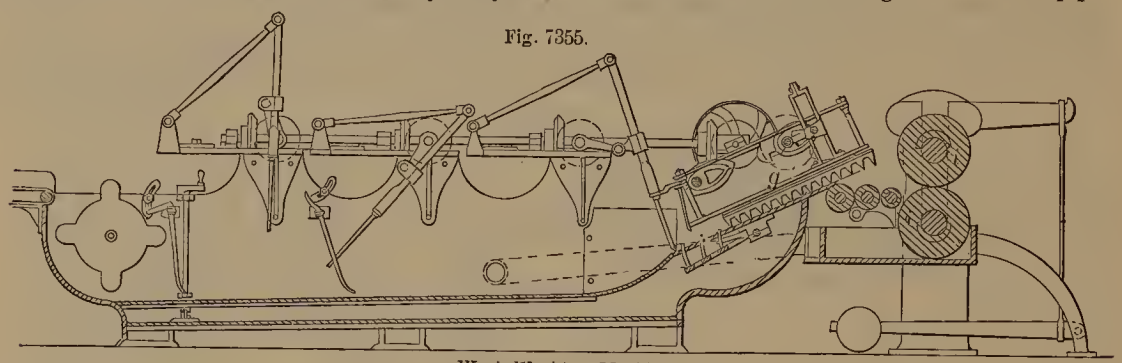
A more recent analysis by Rammelsberg gives in the 100 parts, carbon, 0.867; silicon, 0.136; phosphorus, 0.009; sulphur, 0.002; no aluminium. Samples probably differ. The specific gravity of Rammelsberg's specimen was 7.822.

*Wootz* is believed to be made by a process direct from the ore. See STEEL.

**Wor'dle.** One of the pivoted cams in a draw-head, which form the throat of a die, and which are capable of simultaneous adjustment toward or from each other, to regulate the size of the throat through which the tube or wire is drawn. The draw-head die, thus formed, may be considered equivalent to an adjustable *draw-plate* or *triplet*.

*Wordles* are used in drawing wire and lead-pipe.

Fig. 7355.



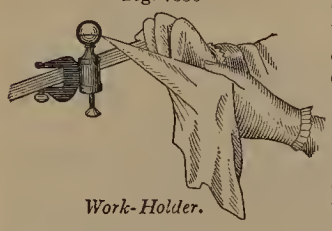
*Wool-Washing Machine.*

**Work.** (*Mining.*) Ores before they are cleaned or dressed.

**Work-box.** A case to hold sewing, spools of thread, and other accessories of a lady's work-table.

**Work'er.** One of a pair of small cane cylinders, called *urchins*, which are arranged around the large card-drum of the carding-machine. The *worker* is larger than its fellow-*urchin*, the *cleaner*. The former takes the fiber from the large card-cylinder, parts with it to the *cleaner*, and the latter returns it to the card-cylinder. See CARDING-MACHINE.

Fig. 7356.



*Work-Holder.*

**Work-hold'er.** A device for holding work while being sewed. That illustrated is clamped to a table. The upper part consists of a fixed and a movable hemisphere, which act as jaws to hold the work, the upper one being raised or lowered by a screw beneath.

**Work'ing-bar'rel.** (*Mining.*) The pump-barrel, in which the piston works.

**Work'ing-beam.** The oscillating-beam, at one end of which is the vertical piston-rod, and at the other the pitman or pump-rod. See CORNISH ENGINE, Fig. 1467, *b*; PUMPING-ENGINE, Plate XLIV.

**Work-roll'er.** (*Knitting-machine.*) A weighted roller which automatically winds up the work as performed. (Not used in hose and other small work.)

**Worm.** 1. (*Ordnance.*) An implement for withdrawing the cartridge from a cannon, when it is not desired to fire the charge.

It consists of two branches of iron or steel twisted in reverse directions, and attached to a staff. They are made of two sizes, one for field-guns and the other for siege and garrison guns.

2. (*Fire-arms.*) A spiral wire on the end of the ramrod, for withdrawing a charge. A *wad-hook*.

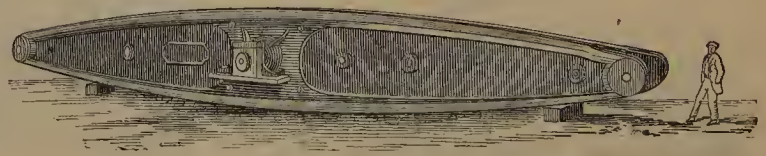
3. The thread on the *shaft* or *core* of a screw.

4. (*Still.*) A spiral pipe in a condenser; a continuation of the neck or beak.

5. The spiral of a cork-screw.

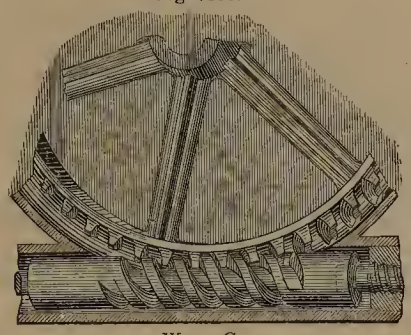
6. A sharp-pointed spiral tool, used for boring soft rock; that which is too hard to be pierced by the *auger*, but not hard enough to require the *jumper*.

Fig. 7357.



*Working-Beam of Cornish Pumping-Engine.*

Fig. 7358.



*Worm-Gear.*

**Worm-gear.** (*Machinery.*) A combination consisting of an endless screw and spirally toothed wheel; used for transmitting rotary motion from one shaft to another, placed at right angles to it.

**Worm'ing.** 1. (*Nautical.*) *a.* Filling up the *contlines*, or vacant spaces between the strands of the rope, with spun-yarn or small rope, in order to strengthen it and render the surface smooth for *parceling* or *serving*.

*b. Link-worming* is by means of chains inserted in the interstices of the strands.

2. The turning of the thread on the barrel of a wood-screw.

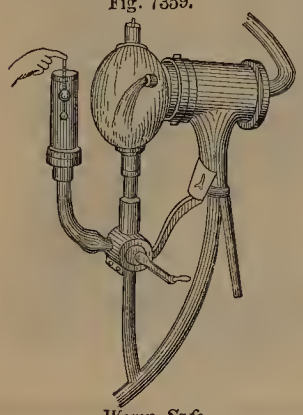
**Worm'ing-pot.** (*Pottery.*) A pot for the ornamentation of pottery in the lathe, by the exudation of color upon the ware as it rotates. The *worming-pot* has three compartments which have quill-tubes emitting the colors at one orifice, so as to give parallel stripes. Curious serpentine ornaments are thus made.

**Worm-safe.** An apparatus to enable the specific gravity of spirits to be ascertained, as they flow from the still, without withdrawing any portion thereof.

The nose-pipe of the worm-tub enters a glass-globe, from the bottom of which the discharge-pipe descends vertically. This has a stop-cock and an upward branch-pipe, surmounted with a glass-cylinder, which, when the stop-cock is opened, becomes filled with spirit, and which receives a hydrometer. The cock mechanism is so arranged that only sufficient to fill the cylinder can be drawn at one time.

**Worm-wheel.** (*Machinery.*) A wheel which gears with an endless screw or *worm*, either receiving or imparting motion. See also WORM-GEAR.

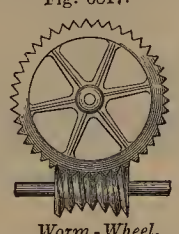
Fig. 7359.



*Worm-Safe.*

By this means a powerful effect with a diminished rate of motion is communicated from one revolving shaft to another by the action of the worm or spiral upon the

Fig. 6817.



*Worm-Wheel.*

spur-wheel. It is a motion common in measuring and calculating instruments, meters, and odometers, a revolution of the worm-wheel moving the spur-wheel to the extent of one cog.

**Wors'ted-ma-chin'er-y.** Machinery for the manufacture of *combing* or *long-stapled* wool, as distinguished from ordinary *woolen*-machinery (which see), which works staple of the ordinary length, and in which the felting quality is much more developed (see FELTING). The breeds of sheep yielding the two arc different. The *Leicester* may be considered the type of one and the *Merino* of the other, though the distinct processes are older than the former name, as a variety, and possibly older than that of the latter kind, which originated in Spain. See MERINO.

Examined under the microscope, *short* wool presents the appearance of being serrated and imbricated. In a fiber of *merino* wool an inch in length, there may be 2,400 of these serrations; in one of *Saxony*, 2,700; in *Southdown*, 2,080; in *Leicester*, only 1,860. In *long* wool these saw-like cusps, or points, are less developed; indeed, in some sorts they are nearly altogether wanting. For the production of woolen cloth that wool is most suitable which possesses the greatest number of these serrations, because it is by means of these that the *felting* process, which is the essence of such cloth, is accomplished. On the other hand, in worsted fabrics this felting operation is avoided, or takes place only to a very limited extent. The fibers are drawn and spread out separately and evenly, by means of the *comb*, which, in all its forms, aims at disjointing each separate lock or ringlet of wool, and arranging the fibers longitudinally. See COMB, 2, page 597.

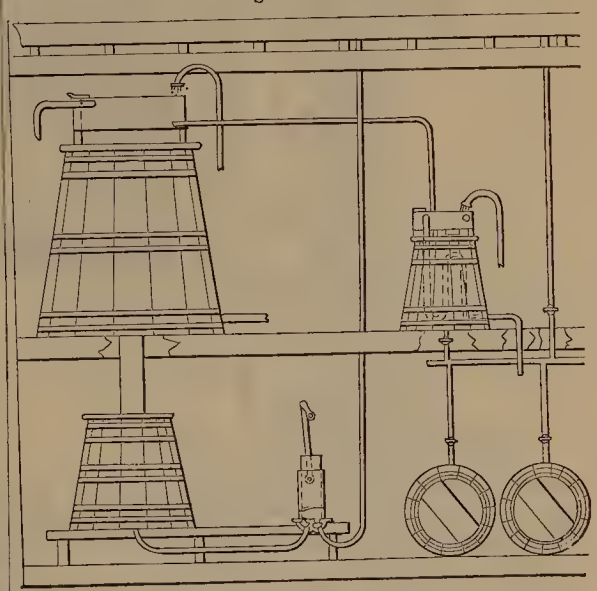
The wool, being *sorted*, is next *washed*. Iron tanks, full of soap and water, are kept by steam constantly at a high temperature. Into these the wool is thrown, and repeatedly drawn through the liquid by iron rakes, which, moved by machinery above, expose it completely to the action of the detergent mixture. The water is then squeezed out by passing the wool between rollers heavily weighted, and the drying process is completed by quickly revolving fans, or drawing the atmosphere through it.

The white and clean wool is then run through *screw-gills*, or revolving leather straps armed with fine iron teeth. It is thus made ready for *combing*. This separates the fibers and lays them parallel. It is analogous to the carding of short wool (*carduus*, a thistle); a *teazle* was first employed, now iron wire. (See CARDING-MACHINE.) The operation of *combing* also removes the shorter fibers which are found even with long wool; these are *bits*, *nibs*, *noils*, according to the custom of a country or district. The process was formerly done by hand, and is shown at Fig. 1395, page 597. It was necessary that the combs should be heated, and for this purpose they were placed in an earthenware stove, or *pot*, as it was called, which was kept at a high temperature by burning charcoal in it. The wool was oiled to render it more pliable.

In the combing-machine, the wool is passed under the action of the long thin spikes of the comb: the locks of wool are drawn out in perfectly parallel lines, each fiber laid smoothly and the *noil* passed over into its appointed receptacle.

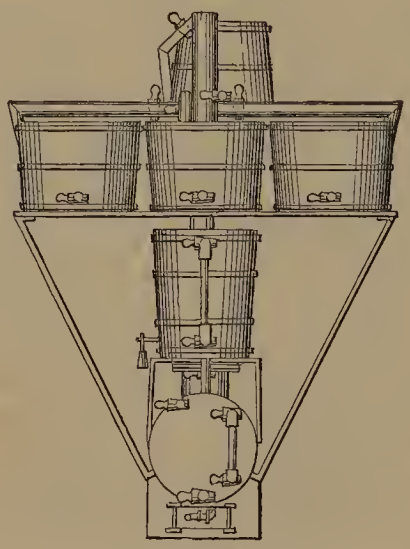
The wool, thus combed, is made up into balls called *tops*, a sort of round *heads*. It is now prepared for spinning by passing the *slivers* or ribbons of combed wool between a series of pairs of rollers, moving with regulated and gradually increasing degrees of velocity, and brought, with corresponding gradations, closer to each other, thus diminishing the space between them through which the wool has to move. The result is to draw out the fibers more completely. This is repeated from six to ten times. The strips of slightly cohering wool thus gain length at the expense of thickness, and are called *rovings;* the word is probably cognate with the sailor's *reefing*, from the Anglo-Saxon *reafian*, to pull. The bobbins on which

Fig. 7360.



*Wort-Condenser.*

Fig. 7361.

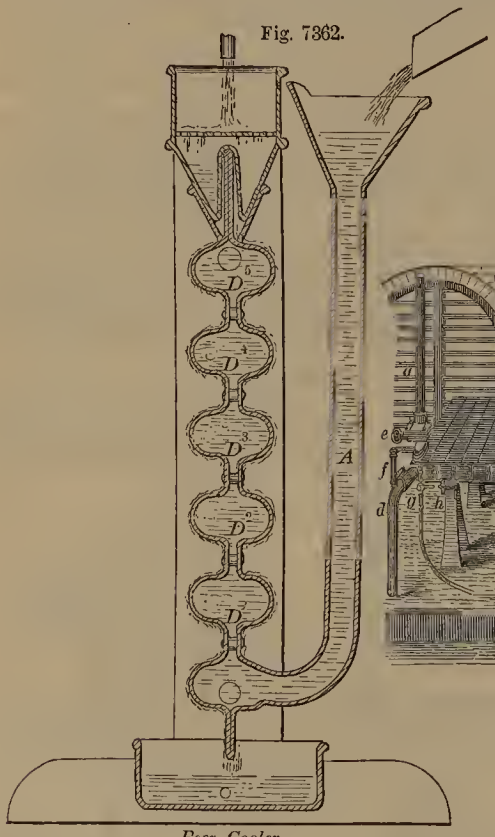


*Apparatus for Brewing Malt-Liquor.*

these rovings are wound, while revolving, impart a slight amount of twisting to the wool, and a sort of light woolen rope is produced with the smallest possible amount of strain. It is immediately from these *rovings* that *yarn* — literally, *prepared* wool (Anglo-Saxon, *gyrnan*, to make ready) — is produced.

The yarn varies according to the quality of the wool from which it is produced, and according to the fineness of thread to which it is spun. In what is called the *fly-frame*, for spinning long wool, the spindles have a velocity of 2,500 revolutions per minute. In the *cop-frame* they attain the speed of 6,000 per minute, or 100 revolutions per second. The tenuity of the yarn is indicated by the *number*, which represents how many

Fig. 7362.




*Beer-Cooler.*

skeins or *hanks* go into a pound. (See HANK.) Thus, 40 *s.* yarn means that in one pound weight there are forty hanks, each measuring 560 yards. The worsted yarn thus produced is used almost entirely for weft.

**Wort.** An infusion of malt. The sweet wort is the first infusion, and is made with one portion water at 140° to 160° Fah., and a second portion at 194°, producing about 167°. A second and a third mash at a higher temperature dissolve other soluble portions of the malt. When fermented, the *wort* becomes *beer*; or *wash* for distillation.

**Wort-con-dens'er.** One for condensing the vapor which rises from the wort in the process of boiling.

In Fig. 7360, the vapor from the boiling wort is condensed in a surface-condenser and returned to the wort before fermentation.

In Fig. 7361, the steam rising from the brewing-boiler during the process of brewing is used for the purpose of heating and preparing the wort for the succeeding brewing.

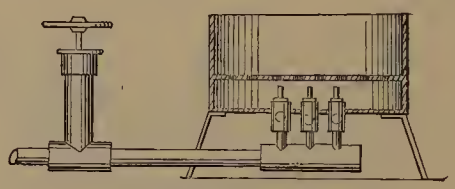
**Wort-cool'er.** Usually a shallow vat of large area, in which the infusion of malt is placed to cool.

Various apparatus have been invented to expedite the process and economize room.

In Fig. 7362, the wort is cooled by dribbling or trickling over the outside of a conduit or receptacle of ice-water. The ice-water descends in tube *A* and rises in the successive chambers $D^1$ $D^2$, etc., flowing out at $D^5$. The wort trickles over the outside of the column, meeting at first the chambers which are about to part with their partially warmed water contents, and reaching last the coldest body of water. See also Fig. 631, page 264; and Figs. 2966-2968, page 1326.

In another form, the beer flowing over the bottom of troughs, which are kept cool by water flowing under them in an opposite direction, is agitated by paddles, which cause all the particles to come in contact with the cooling surface. See also WORT-REFRIGERATOR.

Fig. 7363.

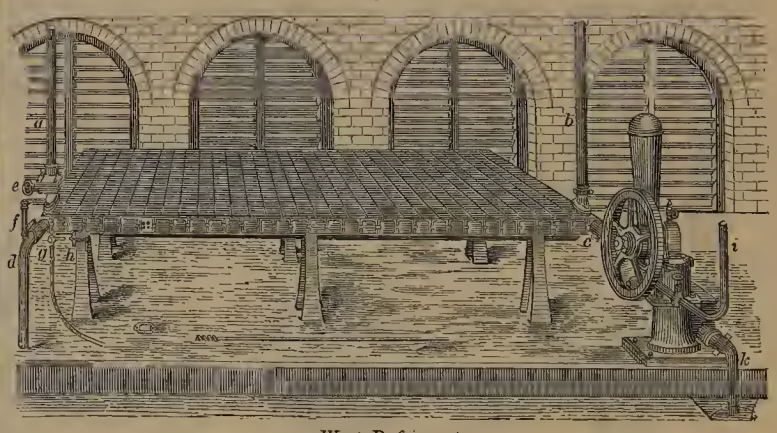


*Air-Exhaust for Extracting Wort.*

**Wort-fil'ter.** One for extracting the clear liquor from the boiled mash.

Fig. 7363 shows the application of a partial vacuum in the sub-compartment of a mash-tub, to cause the wort to accumulate more quickly, and to cause its extraction more thoroughly out of the mash.

Fig. 7364.



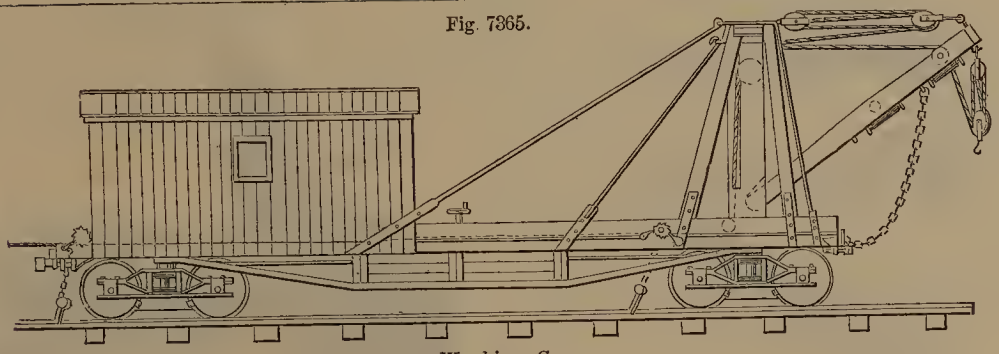

*Wort-Refrigerator.*

**Wort-re-frig'er-a-tor.** An apparatus for cooling wort after boiling with hops and previous to fermentation, in the manufacture of beer.

It is desirable that this process should be effected as soon as possible, in order to preserve the flavor of the liquor, and prevent it from turning sour: and for this purpose it is ordinarily run into shallow vats of large extent, where it remains until its temperature falls to 55° or 60° Fah.

The refrigerator, Fig. 7364, is designed to prevent the formation of sediment and the escape of the aroma, and to avoid loss by evaporation. It consists of a number of long boxes

Fig. 7365.



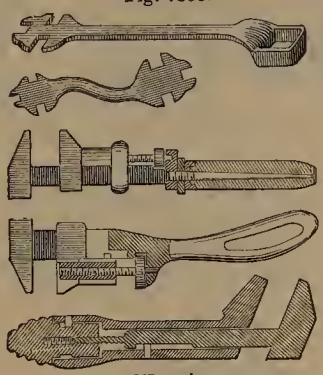
*Wrecking-Car.*

placed side by side, or otherwise if convenient, each having a flow and return passage for the water by which it is cooled, and is provided with copper tubes through which the wort passes.

The hollow covers at the ends of the boxes afford communication for the wort, between one tier of tubes and another, each box being thus complete in itself, and forming a unit of the whole.

By removing the covers a cleaning-brush may be passed through the tubes. *a*, cold-water inlet; *b*, water-outlet; *c*, wort-inlet; *d*, wort-outlet; *e*, water-regulator; *f*, thermometer; *g*, drain-cock; *h*, sample-cock; *i*, steam-pipe; *k*, wort-suction; *l*, tube-brush.

Fig. 7366.



*Wrenches.*

**Wo'ven Pa'per.** Paper made smooth; not ribbed, like *laid* paper.

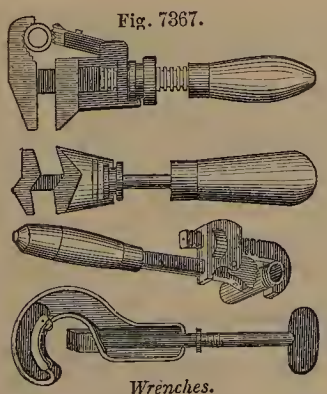
**Wrain-bolt.** (*Shipbuilding.*) A ring-bolt with several forelock holes, used in setting the planks; that is, straining them to their places.

**Wreath.** The *guilloche*, or wreathed chain, like the modern curb, is seen on ancient marble columns and in the Herculanean paintings. It is possibly referred to in Exodus and the Book of Kings, in temple decorations.

**Wreck'ing-car.** One carrying devices for removing obstructions from the track, such as wrecked cars or locomotives, fallen rocks or trees.

In Fig. 7365, the crabs fasten the car in its position on the track. The boom is stepped into the mast, and moved by tackle which connects their respective upper ends. The mast is stepped in the car-platform, and braces by framing and stay-rods.

Fig. 7367.



*Wrenches.*

**Wreck'ing-pump.** A steam-pump specially designed for pumping the water out of bilged or sunken vessels, in order to raise them. The suction and discharge pipes are of great capacity in proportion to the size of the machine, and the valve-passages and valves of the water-cylinders are large, enabling the pump to work up to high speeds when necessary.

See STEAM-PUMP; CENTRIFUGAL PUMP; and, for varieties, see list under PUMP, page 1827.

**Wrench.** A bar having jaws adapted to catch upon the head of a bolt or upon a nut to turn it, or to hold the latter from turning in some cases when the bolt is being rotated.

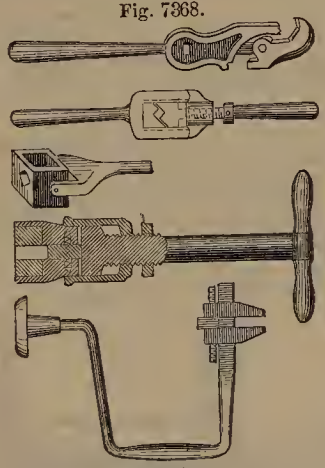
Some wrenches have a variety of jaws to suit different sizes of nuts and bolts.

The monkey-wrench, which has an adjustable inner jaw, is the best form of the wrench, and many patents have been granted for new and improved forms of the tool. See Fig. 3214, page 1473.

See also PIPE-WRENCH, Figs. 3735–3738, page 1711.

Figs. 7366–7368 show several forms of wrenches, for various purposes and adapted to different situations.

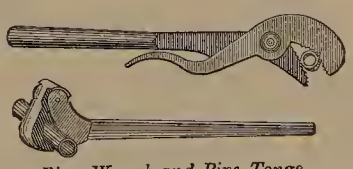
Fig. 7368.



*Wrenches.*

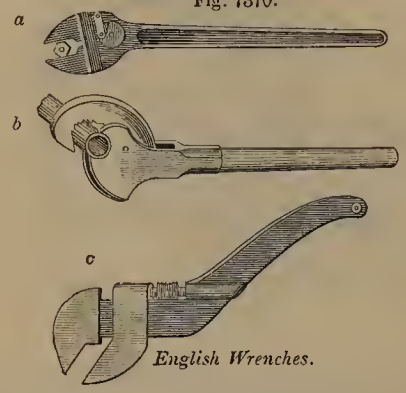
In the self-adjusting wrenches and pipe-tongs (Fig. 7369), the curved inner faces of the jaws are serrated; various sizes of pipes may be firmly grasped by opening the jaws to a greater or less extent and inserting the pipe to a proper distance within the opening, one hand being employed to compress the handle of the movable jaw, and the other to operate that of

Fig. 7369.



*Pipe-Wrench and Pipe-Tongs.*

Fig. 7370.




*English Wrenches.*

the fixed jaw, which acts as a lever when the implement is used as a wrench.

*a* (Fig. 7370), self-acting spanner. *b*, tube-wrench.
*c*, oblique-jaw spanner.
See under the following heads: —

| | |
|---|---|
| Bedstead-wrench. | Monkey-wrench. |
| Breech-wrench. | Nut-wrench. |
| Carriage-wrench. | Pipe-wrench. |
| Claw-wrench. | Ratchet-wrench. |
| Cramp-wrench. | Screw-wrench. |
| Cylinder-wrench. | Spanner. |
| Diagonal wrench. | S-wrench. |
| Double-headed wrench. | Tap-wrench. |
| Hook-wrench. | Wrench-hammer. |
| Key-screw wrench. | Wrest. |

**Wrench-ham'mer.** A hammer having a movable member to form a spanner.

**Wrest.** 1. A turning-instrument, such as a wrench, tuning-key, bedstead-key, spanner, etc.

2. (*Hydraulics.*) The partition in a water-wheel by which the form of the buckets is determined.

**Wrest-pin.** (*Music.*) A pin around which a piano-string is wound, and by turning which it is tightened or loosened as the case may be.

**Wrest-plank.** (*Music.*) The part of the string-frame of a piano into which the *wrest-pins* are inserted.

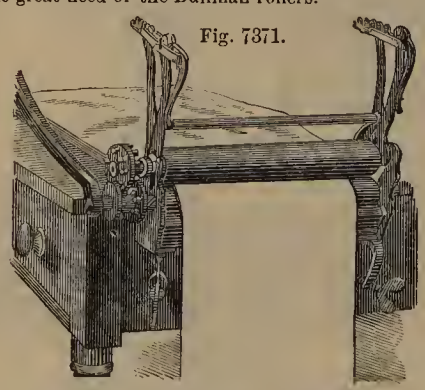
**Wring'er.** See WRINGING-MACHINE.

**Wring'ing-ma-chine'.** A machine for pressing or otherwise draining the water from cloth or clothes.

Bullman's washing and wringing machine (English patent, about 1828) had a pair of rollers, of which the lower one was turned by a crank, and the clothes passed between the two. The inventor of over forty years since very justly remarks that the ordinary wringing injures fine apparel; it is but very lately that the implement has been fairly introduced and then appeared as a novelty.

The vulcanized rubber for an elastic non-absorbing surface was the great need of the Bullman rollers.

Fig. 7371.

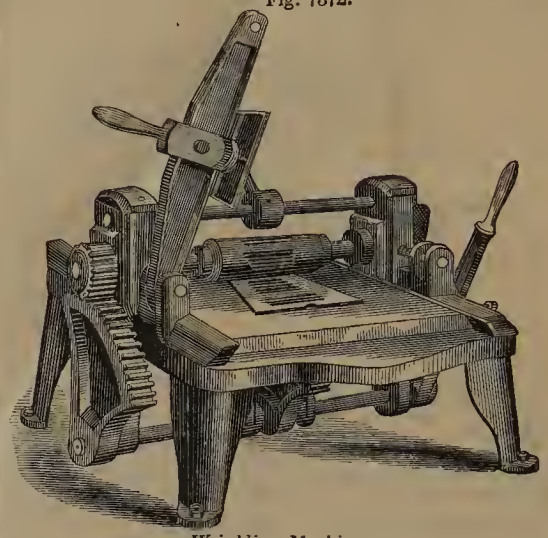


*Palmer's Combined Wringer and Mangle.*

**Wrink'ling-ma-chine'.** (*Leather.*) One to wrinkle transversely the upper leathers of boots and shoes (Stimpson's patent).

**Wrist.** 1. A stud or pin projecting from a wheel, and to which a pitman or connecting-rod is attached. The wrist and so much of the radius of the wheel constitute a crank.

Fig. 7372.

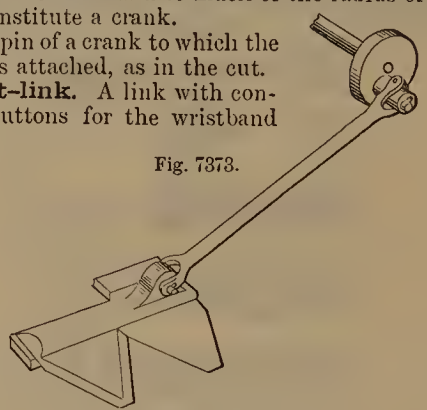


*Wrinkling-Machine.*

2. The pin of a crank to which the pitman is attached, as in the cut.

**Wrist-link.** A link with connected buttons for the wristband or cuff.

Fig. 7373.

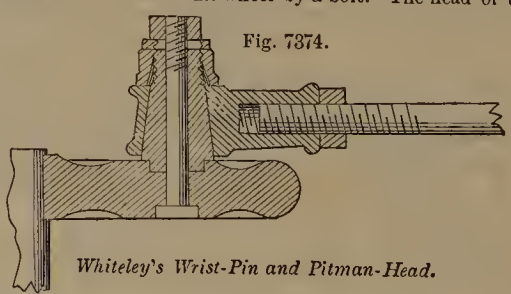


*Harvester Pitman-Connection.*

**Wrist-pin.** A pin passing through the axis of a wrist-connection.

In Fig. 7374, the wrist-pin is a truncate, conical, tubular piece attached to the crank-wheel by a bolt. The head of the

Fig. 7374.



*Whiteley's Wrist-Pin and Pitman-Head.*

pitman-rod is bored to fit this piece, and may be adjusted thereon to take up lost motion. The nut in contact with the head is recessed to form an annular oil-space.

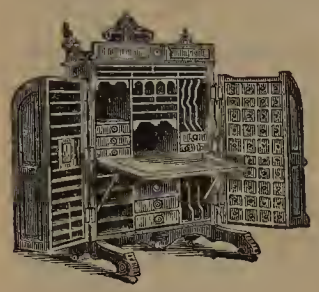
**Wrist-pin Turn'er.** A machine for turning wrist-pins while remaining in their places in locomotives or other engines; or the turning of journals on the end of a shaft. The machine can be applied for dressing and turning the pins when worn, or requiring renewing, without the necessity of removing them from the engine.

**Writ'ing-case.** A portable writing-desk or portfolio.

**Writ'ing-desk.** The writing-case, or *scrinia*, of the Romans was a place to hold the tablets, reed-pens, and styles. Usually a square or cylindrical box.

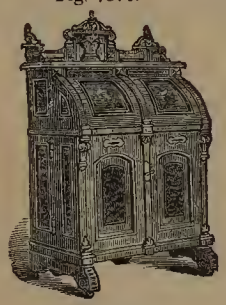
Figs. 7375, 7376, show the Wooton desk, made at Indianapolis, in its open and closed positions. The front portions opening to right and left have file boxes and shelves. The writing-table lets down, exposing a number of drawers, shelves, and pigeon-holes. Book-cases and drawers are below. It is a neat, handsome, and compact affair.

Fig. 7375.



(*Open.*)

Fig. 7376.



(*Closed.*)

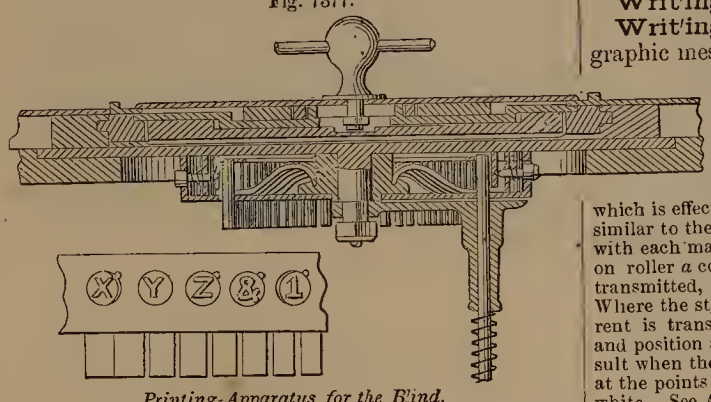
*The "Wooton" Cabinet-Secretary.*

Stiles's combination-desk is a Philadelphia invention. It is specially adapted for reading-rooms, and shuts up closely when out of use. When displayed, it has two writing-desks; the doors afford hooks for paper-files; cupboards and drawers hold archives, books, magazines.

**Writ'ing-frame.** Writing-frames for the blind consist of a frame in which a sheet of paper may be placed, and a horizontal straight-edge, which forms a guide for the hand in making a row of letters. The line being completed, the straight-edge is lowered one notch, and forms a guide for the next line, and so on.

The writing-frame adapted for the punctured alphabet of Louis Braille has a frame of the same character, but the brass-guide has two rows of oblong spaces, in each of which is punctured the system of dots, which represents a letter. The space is capable of holding six dots at such distances as to be readily

Fig. 7377.



*Printing-Apparatus for the Blind.*

distinguished by the touch, and the letters are expressed by the number and position of these dots in the parallelogram: —

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| o | o | oo | oo | o | oo | oo | o | o | o | oo |
| | o | | o | o | o | oo | | o | oo | o |
| | | | | | | | o | o | o | oo |
| a | b | c | d | e | f | g | k | o | t | y |

The above are a few of the characters of Braille's alphabet, and the number of possible combinations is abundantly sufficient for the alphabet, punctuation-marks, accented letters, numerals, etc.

The advantage of Braille's system is that while it may be written with tolerable speed, it may be *read by the blind*, which is an important feature.

Johnston's printing-apparatus for the blind (February 19, 1867) is a machine for enabling a blind person to impress characters in rows and lines so as to be read by the sense of touch. The disk has a circular series of vertical plungers with raised letters on their lower ends to imprint the paper, which is properly fed beneath. Corresponding with the series of vertical plungers are horizontally moving plungers whose raised letters are exposed on the periphery to the touch of the operator. The letter being selected is pressed inward, and the rotation of the disk brings it to the stopping-place, at which an impulse is given to the vertical corresponding plunger. Each selected letter is brought to the same spot, being arrested by engagement with a depression in the stationary ring.

After an impression of a letter is delivered, the paper-frame is moved along one space, so that the next selected letter is impressed in proper succession. When the end of the line is reached, the paper-frame is fed upward, at right angles to its former motion, so as to open up a new space for another line of characters. The frame is also moved back in its former path so as to bring the initial point of the new line opposite to the opening at which the letters are presented. See PRINTING FOR THE BLIND, pages 1794, 1795.

Gall's apparatus, for enabling the blind to write, consisted of a frame on which the paper was placed, a cover with bars to guide the lines, which are written from the bottom upward, and of small stamps with the letters formed of common pins, which are pricked through the paper and read on the opposite side.

See United States patents, Nos.

| | | |
|---|---|---|
| 62,206, | 62,156, | 71,084, |
| 15,164, | 125,024, | 121,026. |
| 132,370, | | |

**Writ'ing-ink.** This does not properly belong to our class of subjects, but we may spare room to state that

Good ink is made of a solution of per-tannate of iron. This salt is obtained by bringing a solution of tannin in contact with salts of the sesquioxide of iron, which yields a deep bluish-black precipitate.

Common writing-ink is made by adding to a clear infusion of nutgalls a solution of protosulphate of iron (green copperas). Mucilage is added to thicken and to prevent settling. This being a tannate of the protoxide is pale at first, but absorbs oxygen, and becomes a tannate of the sesquioxide, becoming black.

Oil of cloves or creosote will prevent molding.

Infusion of galls will restore faded writing.

The Scottish Society of Arts indorses the following to make a gallon of ink: —

| | |
|---|---|
| Powdered nutgalls | 12 ounces. |
| Sulphate of indigo | 8 ounces. |
| Copperas | 8 ounces. |
| Cloves | 2 or 3 ounces. |
| Gum arabic | 4 ounces. |

**Writ'ing-ma-chine'.** See TYPE-WRITER; TYPOGRAPHER.

**Writ'ing-pa'per.** See PAPER, table, page 1610.

**Writ'ing-tel'e-graph.** One which sends autographic messages.

In one, a roller is covered with a ribbon of tin-foil, on which the message is written with a non-conducting varnish, and the roller is caused to revolve at the same time, having a slow endwise motion by means of a screw. A similar roller at the other end of the line is covered with a paper prepared with a solution which is effected by the electric action; this roller has a motion similar to the former. As the rollers rotate, a stylus in contact with each makes a spiral line around them. Where the stylus on roller *a* comes in contact with the tin-foil, the current is transmitted, and the effect is to make a mark on roller *b*. Where the stylus on roller *a* crosses the insulating ink, no current is transmitted, and a white mark of corresponding size and position appears on the prepared paper of roller *b*. The result when the paper is unrolled is a paper ruled all over except at the points where the lines of the message occur, these being white. See AUTOGRAPHIC TELEGRAPH.

**Wrought.** A term used by masons and carpenters in contradistinction to *rough*.

The dressing of stone is done by the pick, stone-hammer, mallet, and chisel.

The dressing of boards, by planer, etc. In this, the terms are expressive of the kind of work, as,

Wrought and framed.
Wrought, beaded, and framed.
Wrought, two sides and framed.
Wrought, framed, and rabbeted.
Wrought, framed, rabbeted, and beaded.
etc., etc.

**Wrought-ir'on Fur'nace.** See PUDDLING-FURNACE.

**Wrought-ir'on Pipe.** See TUBE.

**Wye.** A Y or crotch. Used in many ways as a temporary shore or brace. Also a name applied to a stem or pipe with branches, as a stand-pipe or delivery-pipe with two issues from its summit.

**Wynd.** A truck or low carriage.

# X.

**Xe'bec.** (*Vessel.*) A small three-masted vessel with lateen sails, used for coasting voyages in the Mediterranean and on the ocean-coasts of Spain and Portugal.

**Xy-log'lo-dine.** An explosive compound invented by Carl Dittmar of Charlottenburg, Prussia.

It is a fluid of milky, reddish, or white color, of a consistency varying from that of ordinary sirup to thick broth, and is intended to be mixed with cellulose or other porous substance to form *dualin*, though it may be used singly.

It is composed of nitric and sulphuric acids, and either glycerine-starch, glycerine-cellulose, glycerine-mannite, glycerine-benzole, or analogous substance.

In its preparation commercial sulphuric acid is boiled with pulverized charcoal until it is freed from nitrogen and attains the density of 67° B. 1½ parts of this, or 1 part of the purified acid and ½ part of fuming sulphuric acid, are mixed with 1 part of thoroughly purified nitric acid, specific gravity 48° to 50° B., and the mixture is allowed to stand in a close vessel for from eight to fourteen days, during which time it is subjected to blasts of hot dry air, for the purpose of freeing it from nitrogen.

Glycerine-starch is prepared by roasting starch on iron plates until it turns reddish or yellowish brown, and mixing it with glycerine of 30° B. or upward, free from fatty acids, lime, and chlorine.

Glycerine-cellulose is prepared by treating sawdust, preferably from soft wood, with dilute acid, as hydrochloric, boiling it with an alkali, and afterward drying, pulverizing, and roasting until it turns of a yellowish brown color; it is then mixed with anhydrous glycerine.

Glycerine-mannite is prepared by thoroughly drying and pulverizing mannite, and mixing it with anhydrous glycerine of 30° B.

Glycerine-benzole is prepared by mixing benzole, or benzole-toluole, with anhydrous glycerine of 30° B.

Either of the above, or other suitable substance, analogously prepared, is mixed with the acid mixture above described, in the proportion of about 1 part to 8 or 10 of the acids, and the compound treated to a bath of pure water, or placed in an iron or leaden vessel, when the acids separate from the nitrated compounds; the former being drawn off may be made serviceable for other purposes.

The nitrated substances freed from acid are placed in a bath of soda-lye and stirred until they impart a blue color to reddened test-paper.

They are again washed in pure water, and then rendered anhydrous by being placed in flat chambers and dried with sulphuric acid and chloride of calcium, at a temperature not exceeding 50° C.

A simple apparatus, consisting of a tank, with chambers or worms, and provided with suitable connecting-pipes, has been contrived by the inventor, for mixing and cooling the compound.

Dittmar's patent, for *dualin*, January 18, 1870, embraces "cellulose, nitro-cellulose, nitro-starch, nitro-mannite, and nitro-glycerine, mixed in various combinations, depending on the degree of strength which it is desired the powder should possess in adapting its use to various purposes." See DUALIN.

**Xy'lo-graph.** 1. A WOOD-ENGRAVING (which see).

2. Specifically, a mode of printing or graining from the natural surface of the wood.

A piece of wood is selected of fine quality, having the pattern of grain desired. The surface is treated chemically to open the pores. After it is dry the surface is painted and a sized sheet of paper laid over the board, and both run together between rollers in the manner of copperplate-printing. The paint is then transferred to the board, the differences in the absorbent qualities of the board determining the depth of color. The paper is laid face downward on the article to be ornamented, and rubbed on the back with a soft pad to transfer the impression.

**Xy-loid'ine.** Another name for XYLOGLODINE (which see).

Cotton or other woody fiber treated with sulphuric and nitric acids. See GUN-COTTON; also, Spill's patents, Nos. 91,377 and 101,175.

**Xy'lo-phone.** See HARMONICON; WOOD-HARMONICON.

**Xy'lo-py-rog'ra-phy.** Sometimes called *poker-painting*.

When a hot iron is applied to the surface of the wood, it chars or scorches the wood wherever it touches; and if the operator possesses artistic taste, he can so manage these charred lines as to give them a pictorial arrangement. There were some specimens of this kind in the Great Exhibition, which displayed surprising skill, especially where the surface was charred all over, and then scraped to produce the picture, as in mezzotint.

Copies from Landseer's pictures, and other subjects, have been thus produced with much boldness of effect. The production of designs by pressure depends upon a singular circumstance. If wood be pressed by suitable instruments, it does not recover its original evenness of surface until it has been steeped in water. The artist produces a sort of design on wood, by strong pressure in particular parts; he planes down the protuberant portions, and then soaks the whole in water; this brings up the pressed, or hardened lines, which thereafter stand up as a sort of bas-relief. It is impossible, however, to produce such effectual results by this as by the charring process.

**Xys'ter.** A surgeon's bone-scraping instrument.

**Xys'tus.** A long piazza or walk, covered or uncovered.

# Y.

**Yacht.** A decked pleasure-vessel.

There are about 1,300 yachts in Great Britain, averaging 30 tons. The rigs are various, and many American and European yachts now have steam-power as an accessory, or for use during calms.

The name *yacht* first occurs in English naval records, 1660. The *thalamegus* of the ancients.

**Yan'kee Gang.** An arrangement in a saw-mill (Canada) adapted for logs of 21 inches diameter and under. It consists of two sets of gang-saws, having parallel ways in the immediate vicinity of each other. One is the *slabbing-gang*, and reduces the log to a balk and slab-boards. The balk is then shifted to the *stock-gang*, which rips it into lumber.

See SLABBING-GANG ; STOCK-GANG.

**Yard.** 1. (*Nautical.*) A spar slung from a mast and serving to extend a sail.

Square sails on yards are shown in the paintings of Eléythya, and elsewhere in Egypt.

Yards are either square, lateen, or lug-sail. Yards for square sails are suspended across the mast at right angles, and are of a cylindrical form, tapering from the middle, which is termed the slings, toward the extremities, which are called the yard-arms. At the slings is the place of the given diameter. The distance between the slings and the yard-arms on each side is quartered, the divisions being distinguished as the first, second, and third quarters, and yard-arms.

They are connected with the mast by a *truss*, or *parral*, which slips up and down the mast, at the slings or midlength.

A yard is named from the mast to which it is attached, and its position thereon, as *fore* or *main yard; fore*, *main*, or *mizzen topsail yard*, *topgallant*, or *royal yard*, etc. The *jack-stay* runs along the upper edge of the yard, and has a rod, or perforations, to which the sail is bent. Beneath the yard are *stirrups*, by which the *horse*, or *foot-rope*, is suspended.

The lower yard on the mizzen-mast is called a *cross-jack yard:* it is occasionally carried by a cutter for using a square sail when running before the wind.

A *spritsail-yard* is a spar sometimes carried by vessels, crossing below the bowsprit, a short distance abaft the *dolphin-striker*. It is used for securing the rigging of the jih-boom and flying jib-boom.

*Studdingsail-yards* are slung from the *studdingsail-booms*, and from the fore and main topgallant yard-arms.

The *ring-tail yard* is slung from the peak.

The sails bent on to yards are known as *square*, *lug*, *lateen*, and *settee* sails. See SAIL.

The lug-sail yard is slung at about $\frac{3}{4}$ of its length from the *peak*.

A *settee* is intermediate in this respect between a *lug*-sail and a *lateen*.

A *lateen*-yard is slung at a point about $\frac{1}{3}$ of its length from the peak, and assumes an angle of about 45°.

A yard is

*Swung;* that is, raised and secured by its truss, or parral.

*Struck;* unfastened and lowered.

*Trimmed;* adjusted to the state of the wind, or for parade occasions brought to a position exactly athwartships.

The main-yard of a first-rate is about 100 feet long and 2 feet in diameter at the slings.

2. A measure of length, equal to three feet, into which it is divided ; for the yard is the unit, and is equal to $\frac{1}{1.08719}$ parts of the length of a second's pendulum vibrating in vacuo in the latitude of London at the level of the sea in a temperature of 60° Fah.

**Yard-tack'le.** (*Nautical.*) A *threefold* tackle depending from the end of a lower yard-arm, for lifting boats and other weights.

**Yarn.** Thread prepared for weaving.

1. Cotton yarn is numbered according to the number of hanks contained in a pound of 7,000 grains. Each *hank* or *skein* measures 840 yards.

At the great exhibition of industry, London, 1853, Mr. Houldsworth of Manchester exhibited cotton yarn Nos. 100 to 2,150.

No. 100 single cotton yarn weighs 70 grains.

No. 500 single cotton yarn weighs 14 grains.

No. 700 single cotton yarn weighs 10 grains.

One pound weight of No. 2,150 extends upwards of 1,000 miles in length.

Houldsworth is said to have attained a fineness represented by No. 10,000, one pound of which would extend 4,770 miles. This is marvelous.

Yarn is made into hanks on a reel 4½ feet in circumference, 80 revolutions of which make a *lay* of 120 yards ; 7 *lays* to a *hank* of 840 yards.

Previous to the invention of the mule, the limit of fineness ordinarily reached in England was No. 200. The natives of India reached from Nos. 300 to 400. As appears by the above figures, the *mule* has revolutionized this matter, leaving all mere hand skill far in the rear.

2. Worsted yarn has 560 yards to the *skein*.

Woolen yarn has 1,600 yards to the *skein* or *run*.

3. Linen yarn is wound upon reels, and made up into *leas*, *hanks*, and *bundles*.

The reels differ in size, being respectively 2½ and 1½ yards round.

| | | |
|---|---|---|
| 120 threads of 2½ yards | = | 300 yards = 1 *lea*. |
| 10 *leas* | = | 3,000 yards = 1 *hank*. |
| 20 *hanks* | = | 60,000 yards = 1 *bundle*. |
| 3 *bundles* | = | 180,000 yards = 1 *bunch*. |

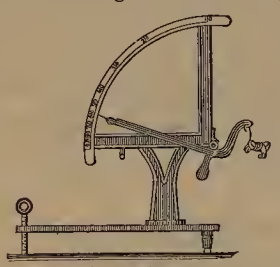
Of the smaller reel : —

| | | |
|---|---|---|
| 100 threads of 1½ yards | = | 150 yards = ½ *lea*. |
| 10½ *leas* | = | 1,500 yards = 1½ *hanks*. |
| 40½ *hanks* | = | 60,000 yards = 1 *bundle*. |

The fineness of linen yarn is reckoned by the number of *leas*, of 300 yards to the pound (cotton, it will be recollected, is reckoned by the number of *hanks*, of 840 yards to the pound), so that 25 or 400 *leas* represent that those rather extreme numbers have that number of *leas* in the pound weight; 7,500 yards and 120,000 yards, respectively, in length of thread.

Another mode of reckoning the grade of a linen yarn is by the weight of the hundle of 60,000 yards. Thus, a hundle of 25 *leas* to the pound weighs 8 pounds ; a hundle of 100 *leas* to the pound weighs 2 pounds ; etc.

Fig. 7378.



*Yarn-Assorter.*

Fig. 7379.

*Yarn Guide and Clearer.*

**Yarn-assort'er.** A kind of bent-lever balance used for ascertaining the size of yarn. A skein is placed in the pan, and a pointer indicates its number on the graduated arc. The assorter for cotton requires a different graduation from that for woolen yarn.

**Yarn-beam'ing Ma-chine'.** A machine for winding the warp-yarn on to the beam. See WARPING-MACHINE.

**Yarn-clear'er.** A fork or a pair of blades, set nearly touching, so as to remove burls or unevenness from yarn passing between them.

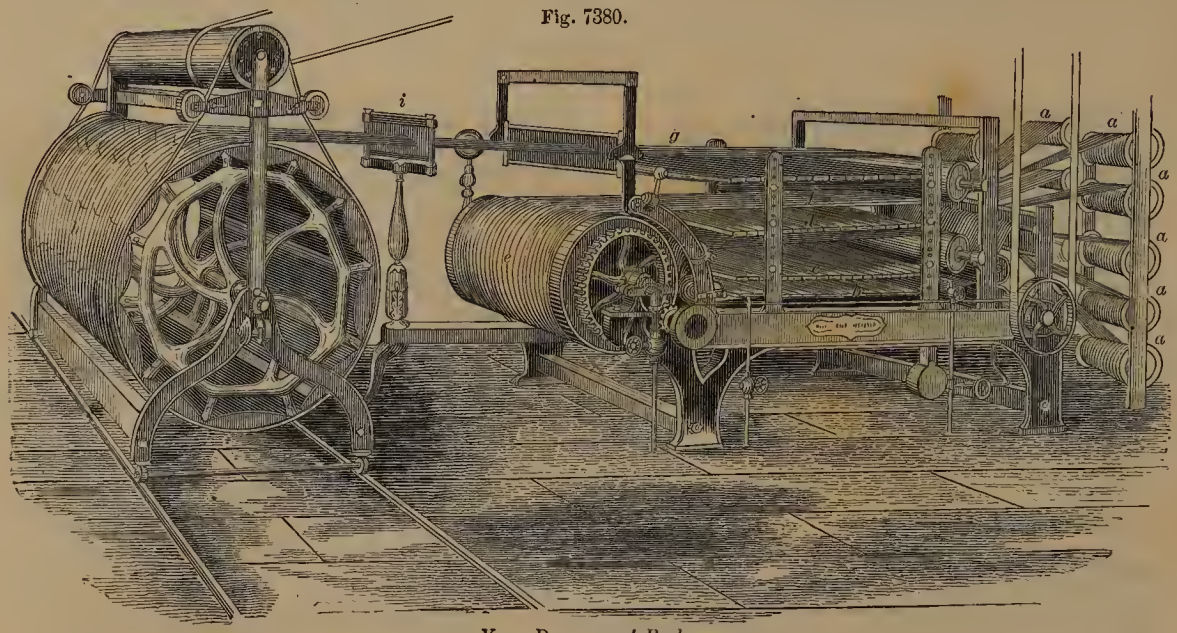
**Yarn-dress'er.** A machine for sizing and polishing yarn.

In the example (Fig. 7380), it consists of a creel carrying rollers *a a*, which deliver their yarn over another roller, from which it dips beneath the surface of the size in a size-box and is thence led upward, passing devices which whip or brush it to remove superfluous size and give it a polish ; it thence is conducted over rollers back and forth, above and below several series of steam-heated pipes arranged flatwise in stories. The letters *b c d e f g* show the course of the yarn which passes through a reed *i*, and is then wound upon a reel *h* in separate hanks, representing the contents of the separate rollers *a a*.

**Yarn-me'ter.** A counter to show the quantity of yarn each spindle has been making.

Brown, Sharpe, & Co.'s yarn-meter indicates the quantity in hanks and decimal parts. They are attached to the front side of one end of the head-rail of a slubber, fly-frame, spinning-frame, or mule. A worm is attached to the end of the front roll, which gears into a wheel on the shaft. A wheel of 77 teeth

Fig. 7380.




*Yarn Dresser and Reel.*

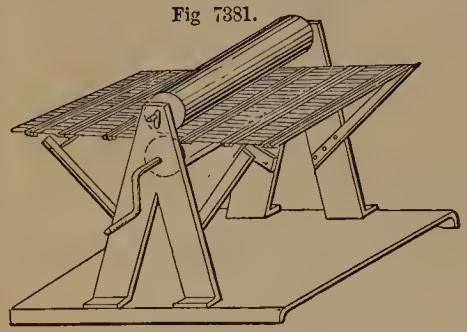
is suitable for a front roll 1¼ inches in diameter, 86 teeth for 1⅛ inches roll, 96 teeth for 1 inch roll.

**Yarn-print'er.** A machine for printing warps previous to weaving. This plan is adopted with some kinds of cheap goods to make stripes across the fabric, as with common carpets. A cheap kind of figured tapestry-carpet is also made by printing in the patterns so as to come right when the warp is raised up in loops upon the face of the goods.

In Fig. 7381, the desired number of skeins are stretched upon the wire-netting so as to be firmly held thereon, the coloring-matter being allowed to penetrate the yarn, so as to leave an even impression upon both sides of the fold.

In Fig. 7382, the yarn is printed between fluted or engraved rollers. The yarn is only exposed to pressure between the

Fig 7381.



*Machine for Printing Yarn.*

ridges of the fluted roller and the opposite portions of the smooth roller, and takes up the color only at those points from the surface of the printing-rollers.

In patent 83,103, means are employed for causing the color-feeding rolls to skip, during the revolution of the printing-cylinder, all those ribs which are to be furnished with some color other than that which they supply respectively.

**Yarn-reel.** A machine for winding yarn from the cop or bobbin.

The bobbins are placed on the skewers, and, the index-finger on the counter being placed at zero, the ends of the yarns are attached to a bar of the reel, which is then rotated until a gong sounds or the finger has made a revolution of the dial. The *cuts* or *leas*, of a determinate length, say 80 times the circumference of the reel, equal to 120 yards (80 threads of 1½ yards each, or $^1/_7$ of a *hank*), are then weighed.

**Yarn-scale.** One for showing the weight of a certain length of yarn, say a *hank*.

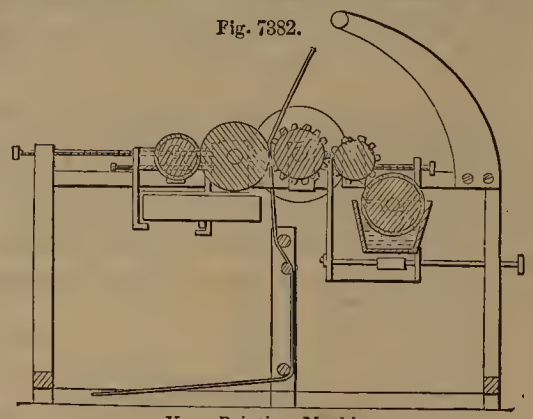
Brown and Sharpe's shows the weights of all numbers in troy grains.

**Yarn-spool'er.** A winding-machine for filling spools or bobbins for shuttles or otherwise. The yarn is on a beam, which has a brake to determine the tension. The yarn is led between rollers and through eyes to the spindles, which are rotated by gearing in the box beneath.

**Yarn-test'er.** An instrument for determining the strength of yarns.

A cut of the yarn to be tested is passed over two hooks, one of which, by turning a hand-wheel *a* that operates a screw,

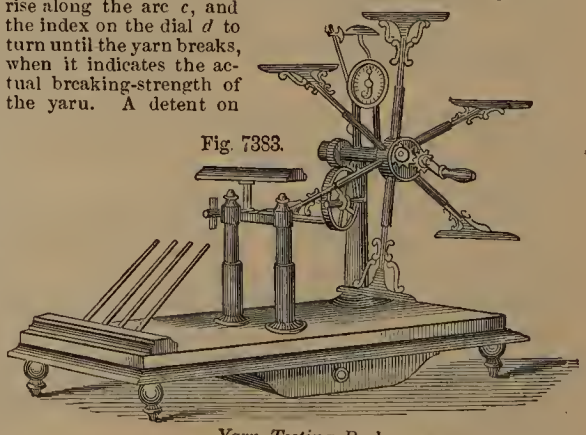
Fig. 7382.



*Yarn-Printing Machine.*

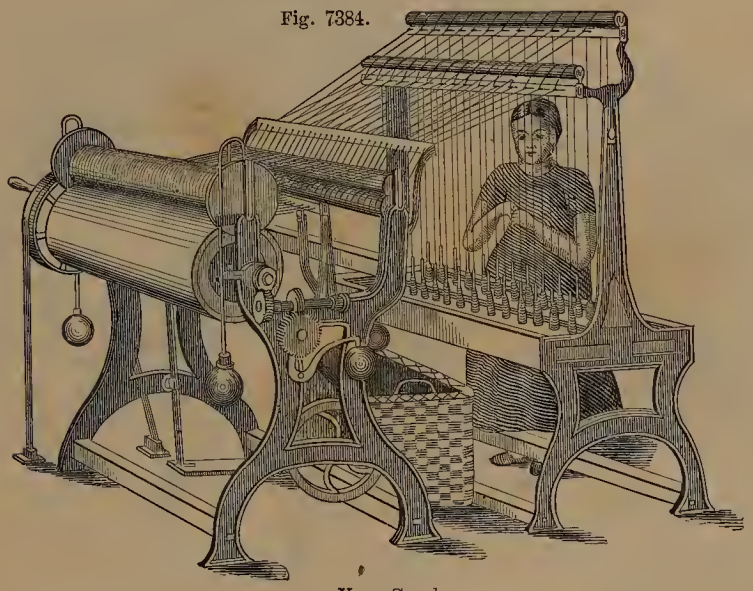
is caused to recede from the other. By this means the yarn is strained until broken. The tension causes the weight *b* to rise along the arc *c*, and the index on the dial *d* to turn until the yarn breaks, when it indicates the actual breaking-strength of the yarn. A detent on

Fig. 7383.



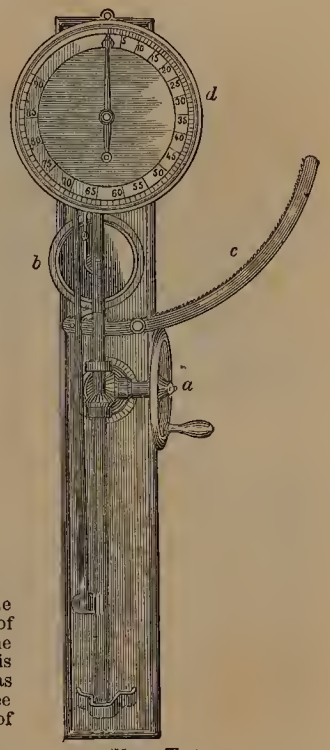
*Yarn-Testing Reel.*

Fig. 7384.



*Yarn-Spooler.*

Fig. 7385.




*Yarn-Tester.*

the weight engages one of the teeth on the arc *c* and prevents it from falling. An attachment also indicates the range of elasticity of the yarn.

**Yarn-wind'er.** See YARN-REEL; YARN-SPOOLER; etc.

**Yas'mas.** A dyed and printed Swiss fabric.

**Yawl.** (*Nautical.*) *a.* A decked boat carrying two masts, one of which is near the stern. It is usually lugger or cutter rigged, the after-mast, called a *jigger*, being the smaller.

*b.* A ship's boat. A *jolly*-boat, usually from 23 to 28 feet long, and ¼ to ⅓ that breadth of beam.

In the British navy it is the fifth boat in point of size; the others being the *launch, long-boat, barge,* and *pinnace.*

**Yel'low-ing.** A process in the manufacture of pins: boiling in an aciduous solution, previous to nurling and tinning.

**Yel'low-met'al.** A sheathing alloy of copper, 2; zinc, 1.

**Yer'gas.** A coarse woolen fabric for horse-cloths.

**Y-lev'el.** An instrument for measuring distance and altitude.

**Yoke.** 1. A bar which connects two of a kind, usually; as the *ox-yoke,* fastened by bows on the necks of a pair of oxen, or by thongs to the horns or foreheads of the oxen in some countries.

"The most approved kind of harness for cattle," says Loudon, "is little different from that of the horse, excepting in the shape of the collar. In many places, however, and especially on the Continent, the ox draws solely by the withers, by means of what is called a *yoke* and *bows.*"

He recommends saddles for hitching singly in carts; also breeching, bridles, halters, and reins.

Post's ox-yoke has hinged plates secured to the top of the yoke, the free ends engaging in notches in the bows. They are substitutes for keys and are not apt to be lost off.

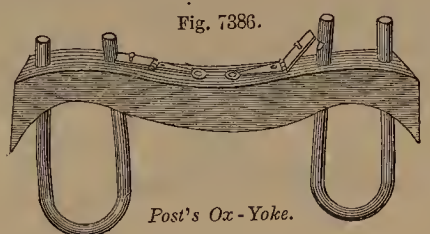
The cattle-yoke of ancient Egypt was various in construction. Sometimes a cross-bar, fastened at the end of the tongue, was lashed to the horns, and at other times we see an angular frame, with openings which fit around the necks, bearing against the shoulders of the animals; a very rough form of double collar for the span of animals. A much more ingenious and complicated contrivance is shown in the cut, which is of a yoke taken from an ancient tomb, and now in the collection of D'Anastasi. The long bar was attached to the end of the tongue and rested on the withers of the cattle, each end being lashed to a pair of cross-pieces shown in the other figure. These lay on each side of the shoulder, and had pads of matting to prevent galling. The strap went under the throat, and served to keep the yoke in place.

All draft animals in old Egypt pulled by the yoke, whether cattle and asses in the fields, or horses to the chariots. In the latter case, the yoke was a splendid affair, having two concavities, which rested on the withers of the horses, the yoke being held in place by neck-bands and girths. See CHARIOT.

Elijah found Elisha in the field, with twelve yoke of cattle before him, and he with the twelfth. This means twelve plows and as many yoke of oxen. (See PLOW.) Job had 500 yoke of cattle.

Horses were yet *yoked* to the poles of the chariots in the time of Xerxes. The sacred chariot of Jupiter (Ormuzd), mentioned by Xenophon in his description of the train of Cyrus, had golden yokes and was drawn by white horses. The Persian monarchs fought from chariots down to the time of the Macedonian conquest. The white horses were raised on the Nicæan plain, in Media, and were a peculiar breed belonging to the king. The Greeks captured them from Xerxes after the defeat at Salamis. The curious yoke over the withers of the Russian horses is probably a survival of an old type. Oxen (1000 B. C.) were yoked by the horns in Greece (HOMER).

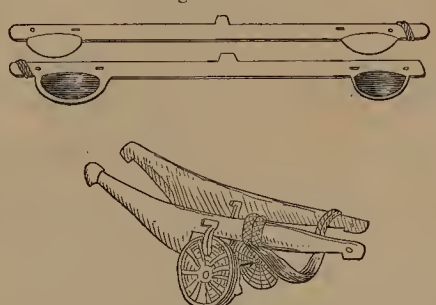
Fig. 7386.



*Post's Ox-Yoke.*

A knotted thong secured the yoke to the pole of the chariot of Gordius, king of Phrygia. It was a complicated tie, and formed the famous Gordian knot which was cut asunder by the sword of Alexander; his favorite mode of solving a difficulty.

Fig. 7387.



*Ox-Yokes (Ancient Egypt).*

Varro (50 B. C.) recommends that in breaking oxen "their necks should be put between forked stakes, one for each bullock," and be gentled while thus fastened by hand-feeding. "Then join an unbroken one with a veteran"; load light at

Fig. 7388.

*Cheetah-Cart.*

first. Virgil says, begin with them when calves. They were yoken by the horns or ueck, the latter being preferred by the writers of the day.

Columella (50 B. C.) condemns yoking hy the horns, and states that they can pull hetter by the neck and breast, which is true. His directions for the treatment of oxen are full and excellent.

In Tuscany, oxen are guided by reins attached to rings passing through the cartilage between the nostrils.

In Africa, a straight stick takes the placc of the ring, and the ends of the bridle-rein are attached to it. The ox is the riding and pack animal of Central Africa.

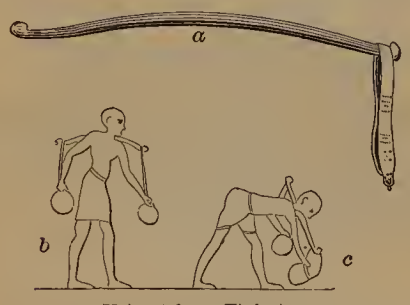
Fig. 7388 is a view of the cheetah, or hunting-leopard cart, from which he is let loose when the prey is seen. The drawing is taken from a model made in the Bombay Presidency, India, and exhibited at the World's Fair, London, 1851. It shows the heavy tongue, which forms a seat for the driver.

2. The *neck-yoke*, by which the fore end of the tongue is suspended from the hames or collars of a span of horses. See NECK-YOKE.

3. A frame to fit the shoulders and neck of a person, and support a couple of buckets suspended from the ends of the yoke.

The ordinary yoke, worn upon the shoulders, and used so commonly in Europe for suspending huckets, etc., in carrying, is found represented very frequently in the Egyptian tomhs.

Fig. 7389.




*Yokes (from Thebes).*

The figures *b c* in the accompanying cut are represented carrying water to irrigate plants.

*a* represents a wooden yoke and leather strap found by Mr. Burton at Thebes, and brought by him to Europe.

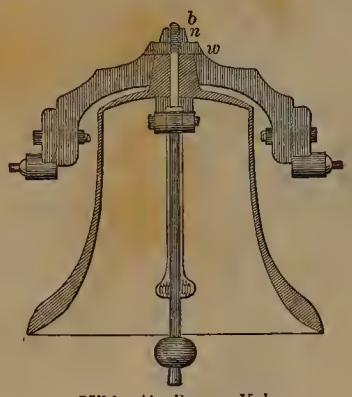
4. Devices to be attached to breachy animals, to prevent their crawling or breaking through or jumping over fences, are sometimes called *yokes*. They are also known as *pokes*, the term *yoke* being more properly applied to the draft attachments of animals, as *ox-yokes*, *neck-yokes*, *shoulder-yokes*.

5. (*Nautical.*) A bar attached to the rudder-head and projecting in each direction sideways; to its ends are attached the steering-ropes or *yoke-lines*, which are handled by the coxswain or steersman, or pass to the drum on the axis of the *steering-wheel*. The *yoke* is principally used in rowing-boats.

6. A cross-bar from which a bell is suspended.

Hildreth's rotary yoke is adapted to a round-shank bell. It contains a conical aperture into which the shank enters, the bell being secured to the yoke by a screw-threaded bolt *b*, to which the clapper is hinged; *n* is a uut, and *w* a washer. This device admits of the bell being turned, so that the clapper may be made to strike at any point of its circumference, thus avoiding the constant wear at two opposite points, which results from the common mode of hanging, and which ultimately destroys the bell.

Fig. 7390.



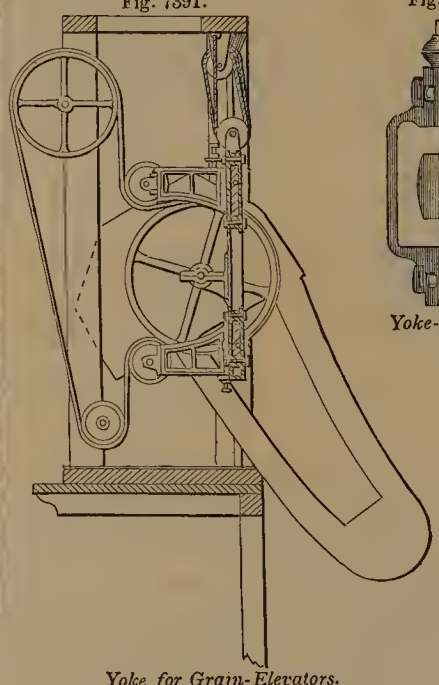

*Hildreth's Rotary Yoke.*

7. A branching coupling-section, connecting two pipes with a single one, as the hot and cold water pipes, with a single pipe for a shower-bath.

8. A head-frame of a grain-elevator, where the belt passes over the upper drum and its cups discharge into the descending chute.

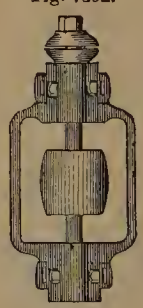
In Fig. 7391, the head-frame of the elevator is vertically adjustable in guides; its lower end entering the hold of the

Fig. 7391.



*Yoke for Grain-Elevators.*

Fig. 7392.



*Yoke-Arbor.*

vessel. The belt is passed beneath one pulley of the adjustable frame and over another of the same, so as to allow of vertical movement of the same without affectiug the belt. See also ELEVATOR.

9. A form of carriage clip which straddles the parts, and is tightened by nuts beneath the plate.

**Yoke-ar'bor.** A form of double journal-box for pulley-spindles, in which a curved branch extending from one bearing to the other on each side of the pulley serves to protect the belt from being chafed or otherwise injured.

**Yok'ings.** (*Mining.*) Pieces of wood used for designating possession. *Stowces.*

**Yufts.** A kind of Russia leather.

# Z.

**Zam-pog'na.** The Italian bagpipes; probably allied to the *sumphonia*, of the Book of Daniel, in the Hebrew version. It was probably a syrinx with bellows, the original type of the organ.

The bagpipes in the *tibia utricularis* of the Romans. See BAGPIPES.

**Zawn.** (*Mining.*) A cavern.

**Zax.** A slater's hatchet, with a sharp point on the pole, for perforating the slate to receive the pin. *Sax; saixe.*

The zax is about 16 inches long and 2 in width; it is somewhat bent at one end, and the spur is 3 inches long.

**Ze'nith-sec'tor.** Invented by Hooke, about 1699, to ascertain whether or no the earth's orbit had any sensible parallax. As modified by Airy, it is principally used in geodetical operations. It serves to determine the zenith point and the zenith distances of stars.

**Ze'nith-tel'e-scope.** A geodetical instrument, invented by Captain Talcott, United States Engineer, for measuring the difference of the zenith of two stars, as a means of determining the latitude. Two stars are selected which pass the meridian about the same time and at about equal distances from the zenith, but on opposite sides of it. It has adjustments in altitude and azimuth, has a graduated vertical semicircle and a level, and a micrometer for measuring the distances between the stars.

**Ze'nith-tube.** Invented by Airy. It is used at Greenwich for stellar observations.

**Zig'zag.** 1. (*Fortification.*) One of the trenches leading toward the besieged works, and communicating between the several *parallels*.

It turns to the right and to the left, but with a general curved course, in such a manner as not to be enfiladed by the guns of the fort.

The *approaches* to Sebastopol, including the *zigzags* and *parallels*, embraced 70 miles of sunken trenches, and required no less than 60,000 fascines, 80,000 gabions, and 1,000,000 sandbags, to protect the men working in the trenches and at the different batteries.

2. A winding chute on the face of a dam to enable fish to ascend. A *salmon-stair; fishway; fish-ladder.*

**Zinc.** Equivalent, 32.5; symbol, Zn.; specific gravity, cast, about 6.8; rolled, 7 to 7.2; fusing-point, 773° Fah.

A rather hard bluish-white metal, tough and not easily broken by blows of the hammer, in its ordinary state at common temperatures, but when heated to a point approaching that of fusion it becomes brittle. At temperatures between 210° and 300° it is ductile and malleable, and may be rolled into thin sheets and drawn into moderately fine wire, which, however, possesses but little tenacity. It preserves its malleability after rolling. Sheet-zinc is largely used as a covering for roofs and for other purposes, and the metal is also used for coating iron, which is then commonly said to be *galvanized*. For this purpose the iron is dipped into dilute sulphuric acid to remove scale, and then plunged into a bath of molten zinc, covered with sal-ammoniac. Combined with copper it forms brass; with the addition of tin and other metals various similar alloys are formed, some of which are distinguished by specific names. The prepared oxide is extensively used as a pigment, and the sulphate is the *white-vitriol* of commerce. It is not found native. Its principal ores are the *red oxide;* the carbonate, or calamine; the sulphide, or *blende*, the dark varieties of which are termed *black-jack* by the English miners; and the silicate, which is usually found associated with the carbonate. The metal itself was unknown to the Greeks, Romans, and Arabians, and in fact in Europe previous to about the middle of the sixteenth century, though it is said to have been used in India and China from an early period.

It is produced in England, France, Belgium, Germany, and in New Jersey and Pennsylvania.

The fact that certain ores yielded a yellow copper (brass) was early known, and the product was highly esteemed; but it was not understood that it was a true alloy, nor was zinc obtained distinctly. This was partly owing to the fact that zinc vaporizes at a certain heat, and the sublimed portions which adhered to the sides of the furnace had no appearance of metal. Mines yielding this gold-colored metal were highly esteemed, and when exhausted the fact was lamented; but in course of time it was discovered that the addition of a certain stone (calamine) to copper, when melting, gave it the desired yellow color. This earth was used for the specific purpose, but it was long ere the truth was elicited that calamine was a metallic ore, and yielded its base to form an alloy with the copper. See BRASS.

Aristotle, Strabo, and various other writers refer to an earth which conferred a yellow color on copper. Brass was considered a more valuable kind of copper.

Ambrosias, Bishop of Milan in the fourth century, Promasius, Bishop of Adrumetum, in Africa, in the sixth century, and Isidore, Bishop of Seville in the seventh century, mention an addition by which copper acquired a gold color. This was, undoubtedly, calamine.

Albertus Magnus (1205–1280) speaks of calamine as a semi-metal.

The *furnace-calamine*, or sublimated zinc, with which the furnaces and chimneys were lined, where zinc-yielding ores were smelted, was thrown aside as useless until the middle of the sixteenth century. It had a place in the pharmacopœia, but this use required but a small portion of the quantity produced.

Erasmus Ebener, who died in 1577, used the furnace-calamine instead of native calamine for making brass. This was introduced at Rammelsberg about 1557. Its use in this connection had been previously described by Albertus Magnus.

White vitriol, the sulphate of zinc, was long prepared, used, and employed before it was known that it was a salt of zinc. It is said to have been first made by Duke Julius at Rammelsberg, in 1570. Its application to make an eye-water is its first recorded use.

The ore (calamine) whose effect on copper had been known for so many centuries is first described as a distinct metal by that brilliant absurdity Paracelsus (died 1541), and is called *zinc*. He says:—

"There is another metal, zinc, which is in general unknown. It is a distinct metal of a different origin, though adulterated with many other metals. It can be melted, for it consists of three fluid principles, but it is not malleable. In its color it is unlike all others, and does not grow in the same manner, but with its *ultima materia*. I am as yet unacquainted, for it is almost as strange in its properties as argentum vivum" (quicksilver).

In the preparation of metallic zinc, as practiced in this country, by what is known as the Belgian method, the ore, having been broken and calcined, is mixed with 33 per cent of crushed coal, and the mass is distributed in charges of 27 pounds to retorts, of which there are 56 in each furnace, arranged in tiers. The orifices of the retorts are cemented in conical tubes of fire-clay, projecting 18 inches beyond the sides of the furnace, and the interspaces sealed with fire-clay. The furnace is then fired up until a heat of 2160° Fah.— the vaporizing point of zinc — is attained. The carbon combines with the oxygen in the ore, and the metallic vapor is condensed into the liquid form by the projecting tubes, which have a temperature below that of the vaporizing point of the metal.

At intervals the molten metal is withdrawn from the retorts, by means of iron hooks or scrapers, and is received in large ladles, from which it is poured into iron molds, forming slabs weighing 30 pounds each. The gases issuing from the orifices in the condensers during the process burn with the most vivid flames and varied colors. Two charges are worked each day. While still hot, the slabs of zinc are taken from the molds and rolled into rough thick plates, 10 × 18 inches; from nine to twelve of these are placed in an iron box, and, the boxes being placed in a furnace, the pack of plates is removed from the furnace and the whole rolled out together, each plate forming a sheet, when trimmed, 7 feet long by 3 feet wide.

In making oxide of zinc, or *zinc-white*, the carbonate and silicate of zinc, as they come from the mine, are crushed, mixed with 33 per cent of coal, and heated in large fire-brick furnaces, provided with an air-blast, the oxygen from which combines with the metallic vapor as fast as it is liberated. The oxide thus formed is conveyed by a blast into a shaft, whence the white flocculent vapor, which is contaminated with various impurities, is driven by blowers through a series of chambers connected by pipes. The impurities are successively deposited, the purest vapors passing through pipes and being finally condensed, as an almost impalpable white powder, in muslin bags attached to the pipes.

It has been proposed to employ zinc for extracting gold from auriferous rocks. The pulverized rock is gradually introduced into a bath of molten zinc, which combines with the precious metal, while the refuse rises to the top and can be skimmed off. The gold may be subsequently separated by distilling the alloy, the zinc passing over and leaving the precious metal behind.

ZINC-SHEETS.

*Thickness and Weight per square foot.*

| Inch. | Inch. |
|---|---|
| .0311 = 10 ounces. | .0611 = 16 ounces. |
| .0457 = 12 ounces. | .0686 = 18 ounces. |
| .0534 = 14 ounces. | .0761 = 20 ounces. |

**Zinc-cem'ent.**

Soret's cement is formed by making oxide of zinc into a paste with a solution of chloride of zinc. This paste quickly sets into a hard mass, which may be applied for stopping teeth and a variety of useful purposes. Dr. Tollens gives a cheaper form of the same cement, which may be used for stopping cracks in metallic apparatus, and cementing glass, crockery-ware, and other materials. He mixes equal weights of commercial zinc-white and very fine sand, and makes the mixture into a paste with a solution of chloride of zinc, having the density 1.26. The mixture sets rapidly, hut allows plenty of time for its application. As it resists the action of most agents, it is very useful in the chemist's laboratory.

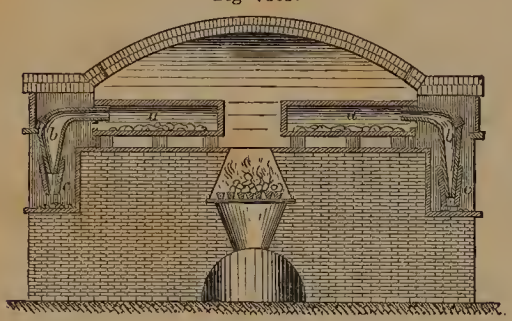
**Zinc-fur'nace.** The carbonate of zinc (*calamine*) and the sulphuret of zinc (*blende*) are smelted by mixing with charcoal in a crucible or retort, and then heating. For the production of the white oxide a process of dry distillation is instituted, and the fumes of the metal are conducted off, condensed and collected for a pigment. For the metal air is excluded from the chambers. See ZINC-WHITE.

Benecke and Shear's zinc-furnace (English) is intended for the distillation of zinc by the process following: —

The ores are roasted in the ordinary way, by stratifying them with fuel and setting fire to the pile.

The ore is then spread out in the air and lixiviated to remove the sulphate of zinc. It is then dried, pulverized, roasted

Fig. 7393.



*Zinc-Furnace.*

to extricate the sulphur, powdered, mixed with carbonaceous matters, and saturated with an alkaline lye.

The prepared ore is then placed in the fire-clay retorts *a*, being introduced at the opening, which is afterward occupied by the neck of the head-piece *b*. *d* is an opening at which spent ores are removed, and is closed and luted during the firing. A lengthening tube *c* is added to the head-piece *b*. The vapor which is sublimated from the ore becomes cooled in the head-piece *b*, and is condensed upon an iron plate beneath. This condensing-chamber is separated by partitions from those of the neighboring retorts, and all points of access are carefully luted. The operation is observed by a glazed eye-hole. The retorts are arranged in two ranks and heated by the fire between them.

See zinc-furnace patents: —

| No. | Name. | No. | Name. |
|---|---|---|---|
| 91,051. | Thoma. | 99,145. | Adams. |
| 91,052. | Thoma. | 145,450. | Richter. |
| 46,198. | Webster. | 16,594. | Kent. |
| 6,180. | Boyden. | 17,333. | Mamier. |
| 32,840. | Müller. | 25,267. | Kalbach. |

See also ZINC-WHITE.

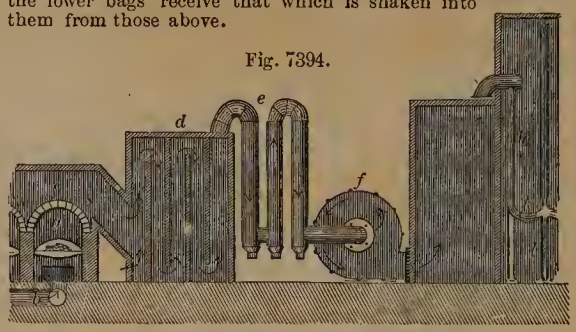
**Zin'code.** The positive pole of a galvanic battery.

**Zinc-og'ra-phy.** The design is drawn on the zinc-plate with a material which resists acid. The surface of the plate being *bit* away leaves the design in relief to be printed from by the ordinary mode in printing from woodcuts. The process does not appear to have made much headway since its introduction in 1816, though some beautiful specimens were made in England more than thirty years back. See PANICOGRAPH; GALVANOGRAPH; GALVANOPLASTIC PROCESS.

**Zinc-white.** Zinc-white (oxide of zinc; ZnO.) is a white powder obtained by the sublimation of the red oxide. This is found in abundance at Mount Sterling, N. J. It is pulverized, mixed with coal, heated in brick retorts, through which blasts of air are passed. The oxygen of the air combines with the vapor of the zinc, and the flocculent oxide is carried off by the draft of air through tubes leading to a chamber where the *zinc-white* falls in the shape of a fine powder.

Fig. 7394 shows the arrangements adopted in the preparation of zinc-white (oxide of zinc). The several furnaces *a* have openings in their tops, communicating with a common flue *c*. The finely ground zinc ore, mixed with its bulk or more of fine authracite coal, is charged into the furnaces, and the mass, when ignited, is fed with a blast of air from a pipe *b*, affording the oxygen necessary for oxidation; the vapor passes through the chamber *d*, which is provided with vertical partitions, extending from the top and bottom, where its progress is checked sufficiently to allow any ash and coal passing over to settle; it is withdrawn thence by the fan *f* passing through the ascending and descending pipes *e*, and forced into a second chamber, where it is cooled and farther purified. It is thence distributed by downcast pipes *h* among a series of horizontal and vertical flannel bags *j k l*, in which it is condensed as a fine white powder; the lower bags receive that which is shaken into them from those above.

Fig. 7394.




*Zinc-White Apparatus.*

*List of United States Patents for Zinc-White.*

| No. | Name and Date. | No. | Name and Date. |
|---|---|---|---|
| 7,351. | Leclaire *et al.*, May 7, '50. | 20,926. | Wharton *et al.*, July 13, '58. |
| 8,308. | Seymour, August 26, '51. | 27,142. | Millbank, Feb. 14, '60. |
| 8,477. | Adams, Oct. 28, '51. | 32,320. | Titterton, † May 14, '61. |
| 8,756. | Jones, Feb. 24, '52. | 33,911. | Weissenborn, Dec. 10, '61. |
| 10,574. | Renton, Feb. 28, '54. | 36,414. | Lewis, Sept. 9, '62. |
| 10,696. | Jones, Mar. 28, '54. | 37,120. | Wharton, Dec. 16, '62. |
| 10,711. | Trotter, Mar. 28, '54. | 38,493. | Lewis, May 12, '63. |
| 12,329. | Selleck, Jan. 30, '55. | 43,587. | Jenkins *et al.*, July 19, '64. |
| 12,333. | Trotter, Jan. 30, '55. | 67,839. | Bartlett *et al.*, Aug. 20, '67. |
| 12,418. | Wetherell, Feb. 20, '55. | 69,573. | Mills, Oct. 8, '67. |
| 12,613. | Gardner, Mar. 27, '55. | 72,032. | Hall, Dec. 10, '67. |
| 13,332. | Jones, July 24, '55 | 73,146. | Wetherill, Jan. 7, '68. |
| 13,416. | Burrows,* Aug. 14, '55. | 73,147. | Wetherill, Jan. 7, '68. |
| 13,431. | Jones, Aug. 14, '55. | 83,643. | Lees, Nov. 3, '68. |
| 13,806. | Wetherill, Nov. 13, '55. | 95,484. | Jones, Oct. 5, '69. |
| 15,448. | Wharton, July 29, '56. | 108,965. | Burrows, Nov. 8, '70. |
| 15,830. | Wetherill, Sept. 30, '56. | 138,684. | Osgood, May 6, '73. |
| 16,594. | Kent, Feb. 10, '57. | 136,685. | Osgood, May 6, '73. |
| 20,655. | Monnier, June 22, '58. | 139,701. | Bartlett, June 10, '73. |
| | | 142,571. | Lang, Sept. 9, '73. |
| | | 145,976. | Trotter, Dec. 30, '73. |

* Extended. † Patented in England.

See also WHITE-LEAD.

**Zir-co'ni-a Light.** One in which a stick of oxide of zirconium is exposed to the flame of oxy-hydrogen gas. Invented by Tessié du Motay. It is said to be entirely unaltered by the heat, and to develop more intense light than any other terrous oxide.

**Zir-co'ni-um.** A rare metal obtained from the minerals zircon and hyacinth by Berzelius in 1824.

**Zith'ern.** An Austrian musical instrument of the

lute order. It has twenty-eight strings, lies on the table or in the lap, and is played by both hands.

**Zo'cle.** 1. A low, plain, square member or plinth supporting a column.

2. A short pedestal; a footstool. *Socle.*

**Zo'e-trope.** This mechanical toy, like the *thaumatrope*, which amused the preceding generation, depends for its interest upon the constancy of visual impressions. See also ANORTHOSCOPE; PHENAKISTOSCOPE; STROBOSCOPE; ROTASCOPE; etc.

It consists of a rotating drum, open at the top, in which, around its inner periphery, are placed strips of paper having figures of men, animals, etc., in varying positions. By turning the cylinder, the images are seen through slots in its upper side, giving the effect of action to the figures. For instance, a porpoise is represented in perhaps a dozen different positions. The turning of the drum brings into view, in rapid succession, the varying positions of the fish until they blend into a perfect image full of motion, and operating to simulate the natural action of the animal.

A man sawing wood, an animal kicking, a clown jumping through a hoop, an acrobat playing with clubs, are thus shown in apparent motion.

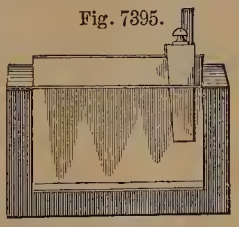
It is described in a paper by W. G. Horner, in the "Philosophical Magazine," January, 1834, "On the Properties of the *Dædaleum*, a new Instrument of Optical Illusion." See also Lincoln's patent, No. 64,117, April 23, 1807.

Its action depends upon the persistence of visual impressions. It is a cylinder rotating on a vertical shaft, and having vertical slits in the sides, through which are viewed the pictures, which are on strips placed around the inside of the cylinder. The vision is interrupted by the spaces between the embrasures, and the object consists of a figure or group, in a series of successive attitudes, which, viewed consecutively, without appreciable interval, appear as a single moving object.

**Zo-oph'o-rus.** (*Architecture.*) The *frieze;* so called on account of the ornaments carved on it, among which are the figures of animals.

**Zo'o-phyte-trough.** A device for retaining living zoophytes or infusoriæ, which are to be examined under the microscope.

Fig. 7395.



*Zoophyte-Trough.*

The two sides are of glass, and it has a glass false bottom sufficiently narrow to admit the edges of two glass plates between it and the sides. This is movable, so that one of the plates may be inserted on each side, forming a reservoir for the water containing the zoophytes. The upper edges of the plates are pressed together by a spring, but may be separated as far as desired by a wedge.

**Zu-mom'e-ter.** An instrument like a hydrometer, to show the condition of fermenting mash.

**Zu-mo-sim'e-ter.** See ZUMOMETER.

**Zy-mom'e-ter.** A measurer of the degree of fermentation.

**Zy-mo-sim'e-ter.** An instrument for detecting the condition and process of fermenting wort or mash. *Zymometer.*

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